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Reenlistment Bonuses and First-Term Retention

John H. Enns

A report prepared for
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY



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PREFACE

This report was prepared as part of Rand's DoD Training and Manpower Management Program, sponsored by the Human Resources Research Office of the Defense Advanced Research Projects Agency (ARPA). With manpower issues assuming ever greater importance in defense planning and budgeting, it is the purpose of this research program to develop broad strategies and specific solutions for dealing with present and future military manpower problems. The goals include the development of new research methods for examining broad classes of manpower problems, as well as specific problem-oriented research. In addition to providing an analysis of current and future manpower issues, it is hoped that this research program will contribute to a better general understanding of the manpower problems confronting the Department of Defense.

This report presents the results of an extended study of reenlistment bonuses and their effects on first-term retention. A previously issued Rand report^{*} discussed empirical findings for a single year, fiscal year 1971. The research findings described in the present report represent an extension of both the methodology and the data base used in the earlier report; four years of reenlistment data (FY 1971-FY 1974) are analyzed using two regression models. The principal questions addressed include: What is the overall impact of bonuses on first-term reenlistment rates? Do the bonuses have different impacts depending on the occupational group to which they are offered? And do different bonus levels (or multiples) produce different marginal increases in reenlistment rates? The regression analysis also allows for the calculation of "improvement factors"--designed to assist managers in planning for future application of the bonus program.

This study has been developed and coordinated with the Compensation Directorate, Office of the Assistant Secretary of Defense for

^{*} John H. Enns, *Effect of the Variable Reenlistment Bonus on Reenlistment Rates: Empirical Results for FY 1971*, The Rand Corporation, R-1502-ARPA, June 1975.

Manpower, Reserve Affairs and Logistics. The results are intended to be useful for administration of the Selective Reenlistment Bonus (SRB) program.

SUMMARY

Over the past decade, reenlistment bonuses have been an important management tool used by the armed services to control the number of first-term reenlistments in selected military occupations. The variable reenlistment bonus (VRB) and its successor--the selective reenlistment bonus (SRB)--are the two programs that have been used. While differing in some aspects, the VRB and SRB programs have both shared common features: a multiple award level structure with bonuses ranging from \$1500 to \$8000; a "selective" application to skills where either high training costs and/or shortages are commonplace, and until recently, the option to pay bonuses in lump-sum or in equal annual installments over the second term of military service.

Although some prior research^{*} exists to aid planners in estimating the response of first-term reenlistments to increases in aggregate military pay, very little information is available regarding the separate effects of bonuses. Unlike regular basic pay increases, bonuses are highly visible, being disbursed at one--or at most four--points in time; they are offered only to select occupations; and they serve to augment only second-term military pay.[†] Thus, there remains an important need for supply response information regarding the separate impact of reenlistment bonuses.

The starting point for the present study is an earlier study[‡] which measured the effects of the VRB, using data for a single year, FY 1971. In that study a statistical model of reenlistment supply was developed and estimated separately for the Army, Navy, and Air Force. The results of this preliminary study were encouraging: in each of the three services the measured bonus response proved positive and

^{*}For example, the Gates Commission Studies (1970).

[†]Although under the new SRB program, post-second-term bonuses are now authorized.

[‡]John H. Enns, *Effect of the Variable Reenlistment Bonus on Reenlistment Rates: Empirical Results for FY 1971*, The Rand Corporation, R-1502-ARPA, June 1975.

statistically significant. Moreover, the bonus responses were quite reasonable when compared with the results of previous studies which attempted to measure reenlistment response to changes in total military pay (the Gates Commission Studies). Nevertheless, it was felt that results based on a single year of data might not be reliable for predicting future bonus effects, given the somewhat unique characteristics of FY 1971 (the relatively low average reenlistment rates and the existence of a highly draft-motivated first-term force). In addition, a number of unanswered questions remained. For example, the preliminary study reached no conclusions regarding the possible differential effects of bonuses on different subgroups (classified by occupational group or personal attributes) of the first-term force.

The present study begins by adapting our earlier methodological approach to the next two years of bonus experience--FY 1972-FY 1973. The results raised many questions concerning the usefulness of results based on a single year of cross-sectional data. The major problem encountered was that of measuring bonus effects during a period when major changes in either bonus policy and/or total force management occur. For example, during FY 1972 the Army initiated a large force reduction by offering "early out" options to many first-termers; the FY 1972 Army reenlistment rates fell substantially below those of FY 1971, and as a result of our ability to measure bonus responses during this period was severely limited. Furthermore, since our initial approach focused on *adjusted* reenlistment rates,* the FY 1973 results were also affected: many individuals who left the Army during FY 1972 under the "early out" policy would, under more normal circumstances, have made their decision the following year.

To overcome the difficulties encountered with these later year group results we adopted a second strategy. Reenlistment rate data for each service were obtained from the manpower management systems of each service; these data measure *unadjusted* reenlistment rates--that is,

* Adjusted reenlistment rates measure the proportion reenlisting from an initial enlistment cohort. Thus, early separations are carried forward and counted as losses during the year in which their normal first-term reenlistment date occurs.

they reflect reenlistment decisions when they actually occur. Four years of data (FY 1971-FY 1974) were used, and a second reenlistment supply model was estimated to generate an estimate of a four-year average bonus response. The results of this second approach, although not without some problems of their own, were quite similar to the results obtained from the earlier VRB study based on FY 1971 data alone.

Our findings, based on both approaches, have led us to the following major conclusions regarding bonus effects:

1. Selective reenlistment bonuses have the desired effect on first-term reenlistment rates. In each of the three services examined (Army, Navy, Air Force), the effect of the bonus is positive and statistically significant.
2. The bonus elasticity under current bonus policy is likely to be about 2.0.* This is a somewhat lower estimate than previous supply studies have provided, but it seems appropriate for present planning purposes under a regime of no lump-sum bonuses.
3. Although some differences in the bonus response between service branches were found, the differences were not consistent over time nor do they seem to be of such magnitude as to require separate bonus management information and/or policies for each service.
4. The different bonus multiples each produce about the same *per dollar* effect.
5. There is no evidence of differences between broadly defined occupational groups (electronics, communications, etc.) in the response to bonus awards; however, this conclusion is tentative since there are methodological problems in testing for such differences.

We were unable to answer two questions quantitatively. First, the issue of whether bonuses are more effective when paid in lump-sum or

* Bonus elasticity is defined as the ratio of the percentage change in the reenlistment rate to the percentage change in second-term military pay which results from a bonus award.

installment payments remains unresolvable with the existing data. Further research using control groups, each receiving one type of bonus payment, needs to be undertaken in order to reach a reliable conclusion. Second, the question as to whether bonus effects have varied over time--due to exogenous factors--is only partially answerable with our study results. Over the past decade bonus effects appear to have been quite stable. It should be noted, however, that over this period civilian labor market conditions were, in general, tight; further evidence from periods of higher civilian unemployment levels needs to be analyzed.

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Throughout the study the author benefited greatly from the guidance provided by Gary R. Nelson. His knowledge of both the institutional and the research problems involved in a study of bonus effects proved invaluable during the planning phase. Later on, his comments on early drafts of the report greatly facilitated the completion of a final report. Of course, any remaining errors are the sole responsibility of the author.

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I. INTRODUCTION

For the past decade reenlistment bonuses have been used by the military services to deal with retention problems in selected skills. These bonuses are flexible because the services may designate a skill eligible for one of several bonus multiples (or for no bonus) and thereby adjust the size of the incentive to meet the severity of the problem.

Under the variable reenlistment bonus (VRB) program^{*} (in effect from January 1966 to June 1974), four bonus multiples were offered; each multiple was worth one month's basic pay times the number of years in the reenlistment contract. In addition, the VRB program included regular reenlistment bonuses (RRBs), which were paid to reenlistees in all skills, thus creating an initial bonus award level. In effect, then, although the VRB system contained five award multiples, only four could be used on a selective basis.

Beginning in FY 1975 the selective reenlistment bonus (SRB) replaced the VRB, introducing some additional flexibility into the system. RRBs were eliminated[†] and a new multiple six was authorized for use in selected Navy skills. As a result, the SRB program now permits up to six multiples to be used for managing decisions at the first-term reenlistment point.

Reenlistment bonuses may be offered to achieve several manpower management goals:

1. They may be used to stimulate reenlistments for the purpose of filling current shortages of career personnel.
2. They may be applied where shortages are projected to occur, even though current manning is adequate.

^{*}For a brief history of the VRB program see Enns (1975), pp. 2-4.

[†]However, under the provisions of "save pay," RRBs are being phased out over a period of time. Section III discusses the save-pay policy in more detail.

3. In skills with high first-term training costs, they can provide a useful tool for obtaining additional man-years of service, thus capturing a larger return on prior investments in human capital.

An entirely satisfactory set of criteria that can be used to determine which skills should be awarded bonuses--and the size of those bonuses--has yet to be developed. The problem is a complex one requiring that the three criteria cited above (and perhaps others) be combined into a single decision rule that can be applied on a skill-by-skill basis.

Regardless of other reasons for using bonuses, the objective of all bonus awards is to increase the number of reenlistments from the eligible pool--that is, to increase reenlistment rates--and reliable estimates of the responsiveness of reenlistment rates to bonus awards are necessary for effective bonus program management. Because past efforts to provide such estimates have been few in number and, of these, several have been flawed by methodological and/or data problems,^{*} a need for reliable information concerning bonus effects remains.

The purpose of this study is to provide quantitative estimates of bonus effects that can be used to manage the current SRB program. We develop econometric models of reenlistment behavior that can be used (1) to measure the overall effect of bonuses on first-term reenlistment rates and (2) to explore for differences in bonus response by branch of service, type of individual, job characteristics, size of bonus (as measured by the bonus multiple), the time period (for example pre-versus post-All Volunteer Force), and the manner of payment--lump-sum or annual installments. Our empirical results provide answers to at least some of these questions and allow us to construct measures of bonus effects--such as improvement factor tables--for use in managing the bonus program of the future.

OVERVIEW OF THE ANALYSIS AND RESULTS

The starting point for the present study is an earlier study[†] in

^{*} Past research is discussed briefly in Sec. II.

[†] Enns (1975).

which the effects of the VRB were measured using reenlistment data for a single year--FY 1971. In that study a statistical model of reenlistment supply was developed and estimated separately for the Army, Navy, and Air Force, using a detailed data base in which individual reenlistment decisions were grouped by military skill and four attribute variables (race, mental ability, pre-service education, and enlistment age) to form observations on adjusted reenlistment rates. The results of this preliminary study were encouraging; for each of the three service models, the measured bonus response proved positive and statistically significant. Moreover, the bonus responses were quite reasonable when compared with the results of previous studies^{*} that attempted to measure reenlistment response to changes in total military pay. Nevertheless, it was felt that results based on a single year of data might not be reliable for predicting future bonus effects, given the somewhat unique characteristics of FY 1971--the relatively low average reenlistment rates and the existence of a highly draft-motivated first-term force. In addition, a number of questions were left unanswered by the preliminary study; for example, no conclusions were reached regarding the possible differential effects of bonuses on different subgroups--classified by occupational group or personal attributes--of the first-term force.

We began the present study by adapting our initial methodological approach to the next two years of bonus experience--FY 1972 and FY 1973. The results were mixed and raised many questions concerning the usefulness of results based on a single year of cross-sectional data. During FY72 and FY73, some major changes in bonus award levels and in force management policy occurred. The FY72 experience is illustrative. During the latter part of that year, the Army initiated a large first-term force reduction by offering "early outs" on a widespread basis. The desired result was achieved; first-term reenlistment rates fell far below those of previous years and became concentrated in a narrow range. Since our regression analysis--designed to measure bonus supply response--depends on variation in reenlistment rates between skills with and without

^{*} Gates Commission Studies (1970).

the bonus, our ability to measure the response to bonuses was severely limited. Moreover, our study focused on adjusted reenlistment rates, in which the reenlistment decisions of early separatees are carried forward to their normal end-of-service year. Thus, the analysis of FY73 data was also affected by the "early out" policies of the previous year.

To overcome some of the difficulties with these latter year results we adopted a second strategy. A second set of reenlistment data was obtained from the manpower management systems of each service. These data measure *unadjusted* skill reenlistment rates--that is, they reflect reenlistment decisions when they *actually* occurred. Thus, reenlistment decisions made during periods of extreme turbulence in force level--such as the Army case described above--can be isolated and treated separately from more normal reenlistment behavior. Four years of data--FY71 through FY74--were obtained, and a second supply model was estimated using pooled data for the four-year period. This second approach, although not without some methodological problems of its own, produced estimates of bonus response quite similar to those obtained from the earlier VRB study.

Because all of our data for this study are from the period covered by the VRB program, to avoid confusion we use the VRB award designators throughout the analysis of Sec. II. In Sec. III we switch to the SRB award multiples so that the measures of bonus effectiveness presented there can be interpreted under the bonus program currently in effect. This conversion is quite straightforward; in most cases, the SRB award level is simply the previous VRB level plus one.

PLAN OF THIS REPORT

In Sec. II we present the study methodology and statistical results. The supply models and regression results for the two models are compared and several statistical tests are made to demonstrate our initial hypotheses about differential bonus effects. Section III discusses two measures of bonus effectiveness. The first of these--pay elasticity--is derived from our regression results and compared with the estimates of sixteen prior reenlistment supply studies. The

second measure is the improvement factor--a measure commonly used to assess the effects of bonuses as well as of other special pays. Two improvement factor tables reflect the SRB effects under existing "save pay" legislation and after save pay expires. The report concludes with a summary of our conclusions in Sec. IV.

II. METHODOLOGY AND RESULTS

This section presents the details of our empirical approach toward modeling first-term reenlistment behavior and estimating the impact of bonuses. After a brief review of three previous efforts to measure bonus responses, we describe the supply model--denoted as Model I--which was developed in the earlier Rand study; discuss the variables and data used to estimate the model; and compare the regression results for all three years (FY71-FY73) across services. We then present a second model (Model II) which is estimated with pooled reenlistment data for FY71-FY74. The results for Model II are presented and compared with those obtained from Model I. The section concludes with two statistical tests, designed to explore for differences in bonus response between different occupational groups and bonus award multiples.

PAST RESEARCH ON BONUS EFFECTS

The earliest attempt to measure the impact of bonuses was a 1968 DoD Study of Special Pays^{*} that sought to obtain estimates by comparing a pre-bonus period (July 1963-December 1965) with the first eighteen months of VRB experience (January 1966-June 1967). A subset of occupations not receiving the VRB or proficiency pay over the entire period was selected as a control group. The remaining occupations were divided into twelve groups based on the possible combinations of the three proficiency pay (pro-pay) levels and four VRB levels. Average annual reenlistment rates were then calculated for all groups; the percentage improvement resulting from the award of VRB and pro-pay was estimated by assuming that, in the absence of special pay, the reenlistment rates would have changed by the same percentage as the control group's rate during 1963-1967. In general, it was concluded that the percentage

^{*} See U.S. Department of Defense, Office of Assistant Secretary of Defense, Manpower and Reserve Affairs, "The 1968 Review of Proficiency Pay and Variable Reenlistment Bonus Programs," unpublished report, April 1968 (hereafter referred to as the 1968 VRB Study). The results of this study were used to support the analysis in *Special Pays, Enlisted Attraction and Retention Incentive Pays*, OSD/M&RA, December 1971.

improvement was greatest for those groups receiving the highest levels of VRB and pro-pay; however, inconsistencies in the results cast doubt on the methodology employed. For example, when the groups were ordered by the total amount of special pay received, some groups with lower levels of payments were found to have greater predicted increases in retention than groups with higher payment levels. Reenlistment rates would be expected to change with varying racial, educational, and mental characteristics of the enlisted force, as well as with changes in alternative civilian incomes, none of which were controlled for in this study. The somewhat inconsistent results obtained in this analysis appear to be due to the lack of control for these influences. Furthermore, the DoD study resulted in a pattern of estimated responses to bonuses which varied in the *per dollar* effect; multiples 1 and 3 were predicted to have much greater marginal effects on reenlistment rates than either multiples 2 or 4.

A 1974 study by the General Accounting Office (GAO)^{*} estimated VRB effects by specifying the dependent variable as the ratio of annual reenlistment rates between FY71 and FY72. In the regression model used for this study the only explanatory variable included was the year-to-year change in VRB award for the skill. The model was estimated separately for the Army, Navy, Air Force, and Marine Corps. The results showed that in all but the Marine Corps, the effect of VRB was positive and statistically significant. Estimates of the bonus response in the Army were significantly lower than for either the Air Force or the Navy. Although no explanation for this finding is attempted in the GAO report, it seems likely that the large Army force reductions during FY72 were responsible for this result. The study limited its attention to measuring the average effect of VRB. In addition, the linear ratio model employed implies that bonus effects are independent of the base reenlistment rates. Thus, the same percentage improvement in reenlistments can be expected from a given VRB regardless of the initial level of reenlistments obtained with no bonus. Finally, the GAO study concluded that the VRB alone was not a reliable predictor of changes in reenlistment

^{*} See *Military Retention Incentives; Effectiveness and Administration*, General Accounting Office, B-160096, July 1974.

rates. In the context of the GAO model, this conclusion is not surprising given the multitude of other factors that have been shown to affect reenlistment behavior. A more completely specified model--which controls for differences between types of individuals, their job characteristics, and other exogenous forces--is required before the effects of bonuses can be accurately predicted.

Kleinman and Shughart (1974) investigated the impact of bonuses on reenlistment rates in the Navy using data for three periods: FY65-FY67, FY68-FY69, and FY71-FY72. The authors estimated regression models in which the dependent variables were changes in reenlistment rates (for Ratings) and the independent variables were changes in dollar VRB awards. An important assumption of the analysis is that changes in non-VRB pay and other factors that influence retention are constant across the Ratings in the sample population. If this assumption is violated, then the regression coefficients measuring bonus response are likely to be biased downward. The estimated regression coefficients showed some tendency to decline over the three periods, but after correcting for inflation, the results across years proved quite similar. Elasticity estimates measured at the mean values ranged from 2.20 in the earliest period to 4.24 in the latest period.

Kleinman and Shughart also found that the length of recommitment was related to VRB level; on average, an increase in VRB of one multiple resulted in an increase of recommitment of six months. Finally, they tested the hypothesis that second-term reenlistment rates are negatively related to first-term bonus awards. The statistical evidence was sufficient to reject this hypothesis, using continuation rates as proxies for second-term reenlistment rates; in other words, the conclusion advanced is that bonus recipients behave in a similar manner to non-bonus recipients at the second reenlistment point.

These three previous studies of bonus effects are each subject to limitations either in methodological approach and/or data coverage. The present study seeks to overcome at least some of these weaknesses. On the methodological side, we have sought to control for as many non-bonus factors as possible that presumably influence reenlistment behavior. Our data coverage is quite exhaustive, covering four years of

VRB experience (FY71-FY74) for the Army, Navy, and Air Force. The two models described below are designed to measure bonus effects using two measures of reenlistment response--adjusted and unadjusted first-term reenlistment rates. We are thus able to avoid misinterpreting results from limited time periods during which short run policy changes (bonus level reduction or major force size changes) tend to dominate.

MODEL I

Description of Supply Model and Data

In the earlier study of VRB (Enns (1975)), a statistical model of reenlistment supply was specified and estimated separately for the Army, Navy, and Air Force using data for FY71.* This model, referred to hereafter as Model I, has the following general form:

$$f(r_i) = \alpha_0 + \alpha_1 B_i + \alpha_2 PP_i + \alpha_3 BASE_i + \beta_1 X_{i1} \dots \beta_n X_{in}, \quad (1)$$

where $f()$ = a functional transformation of the dependent variable r ,

r_i = the reenlistment rate in skill i ,

B_i = dollar amount of VRB plus regular bonus in skill i ,

PP_i = dollar amount of second-term proficiency pay in skill i ,

$BASE_i$ = dollar amount of second-term base pay in skill i ,

$X_{i1} \dots X_{in}$ = a set of binary variables denoting race, education level, mental aptitude, entry age of enlisted personnel, and dependency status for individuals in skill i ,

and $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$, and $\beta_1 \dots \beta_n$ are parameters to be estimated.

*The theoretical model of reenlistment supply (or occupational choice) underlying this statistical model has been widely used and discussed. See, for example, Wilburn (1970), Kleinman and Shughart (1974), and Enns (1975). The distinctive feature of the model described above is that bonuses are separated from other military pay components. In

Model I was estimated separately for each of three years (FY71-FY73) using a subset of military occupations defined by DoD occupational group codes. The sample population includes all skills in DoD groups I through III, plus selected skills from groups IV-VIII. Groups I-III contain skills that are primarily technical--electronic and communication skills are heavily represented. These three groups also contain the majority of bonus eligible skills for the period under consideration. By contrast, the skills included from Groups IV-VIII are primarily mechanical, clerical, and supply skills, for which the bonus has not usually been offered on a widespread basis.

The Rate of Reenlistment (r)

The observations used to estimate Model I were formed by classifying individual personnel records into cells defined by service, military occupation (Army MOS, Navy Rating, Air Force AFSC), level of pre-service education, mental aptitude, dependency status, race and age of entry. Reenlistment rates were then calculated for each cell using the definition of an adjusted rate of reenlistment. Applying this definition for FY71, the numerator of a rate for any cell is the number of entrants to the service during FY67 who had extended their initial obligation, by June 30, 1971, for a minimum of two years.* This procedure does not require a reenlistment decision to be made in the technical sense because we count as reenlistments those individuals with extensions of two years or more. However, this definition does correspond exactly to the official

most of the previous reenlistment studies, the second-term military pay variable has been aggregate (see App. D).

The statistical model used in the present study differs in two respects from the earlier model estimated for FY71. In the earlier model, a variable measuring alternative civilian earnings was included. However, because data required to construct this variable for FY72 and FY73 were not available, it was dropped from the present formulation. For our purposes this is not a serious omission since the variables capturing individual attributes are all correlated with civilian earning opportunities and thus control for this influence. Second, because the data on dependency status for FY71 were not complete for all sample observations, this variable appears only in the FY72 and FY73 equations.

* For the Army, we use the cohort entering service during FY68 to reflect a three- rather than four-year initial obligation. For the Navy, we exclude Ratings containing six-year obligors (6 YO's) since these persons "automatically" reenlist at the end of their first four years.

DoD requirements for bonus eligibility. Similar procedures were used for later enlistment cohorts to calculate the number of reenlistments during FY72 and FY73.

The denominator of the reenlistment rate includes all reenlistees and separations from the original entry cohort. Separations exclude those personnel whose separation code indicated misbehavior or otherwise unsatisfactory service; such individuals were considered ineligible for reenlistment. Finally, all individuals in the initial entry cohorts who had passed their normal end-of-service dates without separating or reenlisting were dropped from the sample, since their first-term reenlistment decision had not been made at the time our data were collected.*

The procedures described above resulted in a number of cells with reenlistment rates equal to 0 or 1. For reasons discussed below, a logit transformation of the dependent variable, r , was chosen for the estimating model. In this model, the dependent variable is $\log_e(r/(1 - r))$, which is not defined for values of 0 or 1. We adopted the following strategy for dealing with this problem. First, cells with less than five eligibles were dropped from the sample. Second, for those unusable cells remaining, the value of r was set to 0.01 or 0.99 for observations of 0 and 1, respectively.

Most prior reenlistment supply studies have measured aggregate military pay in present value terms for regression purposes. The theoretical reason for this formulation is that prospective reenlistees base their reenlistment decisions, in part, on a comparison of the present value of alternative income streams--military versus civilian. In our model, military pay is divided into three components. Presumably, reenlistees view each component differently with respect to both risk and time horizon. The bonus has been paid both in lump-sum and installment payment form; as a result, the appropriate rate of discount for this component is not straightforward. Similarly, for pro-pay and basic pay there is no evidence to suggest the appropriate parameters for the rate of discount or time horizon that characterize first-term reenlistment

* This group is quite small--less than 1 percent of the total eligibles in all cases. Generally, these personnel are on short-term extensions from 1 to 23 months.

decisions. In view of these difficulties, this study uses undiscounted second-term military pay components in the model of supply. In other words, we assume a four-year time horizon and allow the regression coefficients of the pay variables to capture the implied discount rates. This procedure results in a coefficient for bonuses (B) which--strictly interpreted--applies only for lump-sum payments.

The Reenlistment Bonus (B)

The total reenlistment bonus offered to personnel in a given military specialty was estimated using data from individual servicemen records. The regular reenlistment bonus consists of one month of base pay multiplied by the number of years in the reenlistment contract. For the Navy and Air Force, a four-year reenlistment term is required; in the Army, the second-term commitment may be from three to six years. Because our data were inadequate for the purpose of calculating the exact reenlistment terms chosen for Army personnel, we assumed a four-year reenlistment term and computed the average bonus award for this period.

Eligibility for the VRB is determined by MOS codes in the Army, AFSC codes in the Air Force, and Ratings in the Navy.* To compute the variable reenlistment bonus, we use the VRB multipliers in effect during FY71-FY73; for military specialties designated eligible for VRB, the multiplier times the regular reenlistment bonus gives the dollar amount of VRB. The total reenlistment bonus (B) is then equal to the regular reenlistment bonus plus the VRB award.

Proficiency Pay (PP)

There are three levels of shortage specialty pro-pay (P_1 , P_2 , P_3) for which enlisted men may qualify after completing their initial enlistment term. The maximum dollar awards per month are \$50 (P_1), \$100 (P_2), and \$150 (P_3). For this study, we assume that prospective reenlistees view specialty pro-pay levels as unchanged throughout the second term and that the maximum dollar awards are paid. Like VRB, proficiency pay is awarded to designated Army MOSs and Air Force AFSCs; thus for the

*Some NECs (Naval Enlisted Classifications) were also eligible to receive VRB. However, our sample does not contain any of these groups.

Army and Air Force the estimate of second-term proficiency pay for a military specialty is straightforward. In the Navy, eligibility for proficiency pay is determined by both NEC designators and Ratings. The problem is more complicated since several NEC codes, some eligible for pro-pay and some not, may be included in a given Rating. For this analysis we compute the average pro-pay paid to individuals in each Rating and use this value in the regression model.

Base Pay (BASE)

Variations in base pay among individuals are due primarily to differences in rank and length of service. Although second-term base pay is influenced by promotion opportunities in a given specialty, there is no simple way of determining the probability of promotion in advance. As a result, the estimates of second-term base pay were constructed using the average rank of personnel facing the reenlistment decision.* The actual dollar amount of this type of pay is then calculated using the published FY71-FY73 pay data for enlisted men with five to eight years of service.

Individual Attribute Variables

Individual attributes are included in the model to control for a variety of factors that affect the supply response to reenlistment bonuses. The level of pre-service education has an impact on a person's ability to seek and obtain civilian employment. Differences in mental ability, dependency status, or race are likely to affect individual preferences for military life. Finally, a person's age at initial entry into military service may indicate positive or negative views regarding civilian opportunities; for example, older enlistees are likely to have experimented with the civilian job market and decided to pursue a military career instead. There is a reverse hypothesis, however; older men may have been more strongly draft-motivated and thus less likely to reenlist.

* This procedure thus understates second-term basic pay. However, no estimation problems arise unless promotion patterns among skills are different in the second term than in the first term, and prospective reenlistees perceive such differences.

Each of the variables included in the model to control for the influence of individual attributes was assigned binary values. Two education level variables were used: high school education (HS)--graduate (0), non-graduate (1); and college education (college)--no college (0), some college (1). The remaining attribute values were defined as follows: race (RACE)--white (0), non-white (1); mental ability (AFQT)--AFQT percentile score 10-64 (0), over 65 (1); age of entry (AGE)--less than or equal to 19 years, 6 months (0), greater than 19 years, 6 months (1); and dependency status (DEP)--no dependents (0), one or more dependents (1).

Functional Form for the Supply Equation

The earlier VRB study presented regression results based on a semi-log supply equation specification. For the present study we adopt a logistic form for the supply equation. In this logistic model the dependent variable is $\log_e(r/(1-r))$. The choice of a specific functional form is essentially arbitrary; short of having many observations on reenlistment rates and pay levels, one can never "know" the correct shape of the supply curve. Despite this inherent difficulty there are several reasons for preferring a logistic specification:

1. The logistic function is bounded by 0 and 1.0 as is the reenlistment rate (r); thus, projections of bonus effects using this model can never result in predictions outside the observable range for r (as can happen with other functional forms).
2. The response to the bonus is *not* independent of base or no-bonus reenlistment behavior. This is an intuitively appealing property of the model. Thus, for example, skills with unpleasant working conditions (which serve to depress the reenlistment rate) will usually be predicted to have a lower response to a given award than skills with more desirable job conditions.*

* Assuming, of course, that other influences affecting reenlistment behavior (i.e., personal attributes) are the same among the different skills.

3. Statistical tests designed to determine which functional form best "explains" the unadjusted reenlistment data for FY71-FY74 suggest that nonlinear functions are superior to linear functions.*
4. Many previous studies of reenlistment supply have used a logistic model; thus our results may be compared directly with the results of other research.

Model I Results

The regression results for the FY71-FY73 equations are shown in Table 1.[†] The results show that in all but two cases the effect of the bonus is positive and statistically significant at the 5 percent level. Both the FY72 and FY73 Army coefficients are not statistically different from zero; the FY72 coefficient is also negative. The probable causes for these unsatisfactory results are discussed below. The pro-pay results for the Army and Air Force show that although the effect of pro-pay is positive as expected, the statistical significance of this variable is low in all cases. The effect of basic pay is generally negative with two exceptions--Navy (FY73) and Air Force (FY72). This implausible result was also found in the earlier VRB study; it apparently comes from the fact that promotion rates are not independent of prior reenlistment behavior. For example, during periods of increased demand for manpower, such as the 1966-1969 Vietnam period, the promotion rates are likely to be relatively high in those skills where reenlistment rates are relatively low. Under such conditions, base pay is not truly exogenous in a cross-sectional supply model.[‡]

The effects of personal attributes on the supply of reenlistments are generally in line with a priori expectations. The coefficient for

* See App. A for tests of semi-log versus linear models.

[†] Estimation of Model I was accomplished using the method of ordinary least squares. To correct for possible bias due to heteroscedasticity the observations were weighted by $\sqrt{r(1-r)N}$, where N = total eligibles in each cell.

[‡] Similarly, bonus levels are not strictly exogenous to the model. The point is discussed below.

Table 1

LOG-LOGIT REGRESSION RESULTS FOR INDIVIDUAL YEARS USING ADJUSTED REENLISTMENT RATES
(FY71, FY72, FY73)

Service/ Year	Constant	VRB (\$000)	Pro-Pay (\$000)	Base (\$000)	Race	AFQT (I&II)	HS	College	AGE	DEP	F- Statistic ^a	\bar{R}^2	Degrees of Freedom
<u>Army</u>													
FY71	-2.4 (3.2) ^b	0.092 (4.7)	0.031 (0.98)	-0.25 (-3.2)	0.74 (4.6)	-0.22 (3.7)	0.25 (5.2)	-0.55 (7.3)	0.03 (0.01)	(c)	31.9	0.32	631
FY72	-1.4 (-1.9)	-0.002 (-0.09)	0.004 (0.06)	-0.03 (-1.2)	0.39 (2.7)	-0.01 (-0.07)	0.15 (3.2)	-1.2 (6.8)	-1.2 (-0.9)	1.3 (6.9)	43.6	0.33	1987
FY73	-2.1 (-2.7)	0.05 (1.0)	0.009 (0.07)	-0.04 (-2.1)	0.46 (6.7)	-0.04 (-1.1)	0.23 (2.8)	-0.87 (-3.4)	-0.18 (-1.2)	1.6 (7.0)	50.7	0.29	1893
<u>Navy</u>													
FY71	-2.1 (-1.0)	0.159 (6.2)	--	-0.55 (-7.1)	0.52 (2.6)	0.16 (1.2)	0.25 (1.3)	-0.25 (-1.8)	0.28 (2.0)	(c)	13.8	0.20	400
FY72	-1.9 (-2.0)	0.050 (3.1)	--	-0.01 (-0.26)	0.80 (5.0)	-0.004 (-0.01)	0.75 (5.9)	-1.12 (-11.8)	0.24 (2.7)	1.2 (13.7)	70.5	0.40	660
FY73	-2.5 (-2.6)	0.046 (2.9)	--	0.039 (0.98)	0.90 (6.2)	0.06 (0.75)	0.70 (3.4)	-0.60 (-3.2)	0.30 (2.8)	0.80 (12.6)	65.3	0.38	550
<u>Air Force</u>													
FY71	-2.4 (-4.2)	0.170 (8.2)	0.014 (0.68)	-0.089 (-0.09)	0.24 (6.2)	0.09 (1.0)	0.59 (6.2)	-0.41 (-0.40)	-0.11 (-4.6)	(c)	34.1	0.17	861
FY72	-3.2 (-3.1)	0.101 (7.2)	0.021 (1.3)	0.007 (0.84)	0.68 (7.9)	0.03 (0.06)	-0.17 (-2.0)	-0.50 (-7.0)	-0.17 (-3.2)	1.2 (23.5)	85.6	0.46	1269
FY73	-1.5 (-1.2)	0.040 (4.5)	0.006 (0.04)	-0.01 (-2.3)	0.48 (6.3)	-0.04 (-0.09)	-1.2 (-16.4)	-0.46 (-6.8)	-0.15 (-2.4)	1.3 (26.3)	147.9	0.34	1020

^aF-statistic significance levels = 1 percent.

^bt-statistics are shown in parentheses.

^cData deficiencies prevented inclusion of dependents (DEP) in the FY71 equations.

non-whites is consistently positive and of high statistical significance. Non-high school graduates are more likely to reenlist; the effect of having attended college is consistently negative. High mental ability shows up as a negative influence in the Army, but the results are mixed for the other two services. The effect of older age at entry is negative in the Air Force and Army, which supports the hypothesis that older men who enlisted during this period were more likely to have been draft-motivated and thus less likely to reenlist. In the Navy results, however, the effect of greater age is consistently positive. Finally, in the FY72 and FY73 results, the existence of dependents has a strong positive influence on reenlistment.

Differences in Bonus Coefficients Between Years

The coefficients in Table 1 that are of primary interest for this study are the bonus coefficients. These are largest, in each service, for FY71; the FY72-FY73 coefficients are generally lower by a factor of three or more. There is no obvious reason for expecting bonus effects to be so different between years. To interpret these results it is necessary to look more closely at (1) the bonus policies that were in effect and the overall force changes that took place during this period, and (2) the possible statistical biases in the estimates of bonus effects.

Policy Changes

The Army situation creates the most difficulties for our analysis. During the years FY71 through FY73, the bonus program was administered in a relatively stable manner; approximately the same number of skills were designated bonus eligible in each year, although the size of the awards declined somewhat over the period. But midway through FY72, the Army initiated a large force reduction program which resulted in separations of roughly 100,000 first-termers in the ensuing three-month period. Many of these voluntary separations were encouraged by the offer of an "early out"; that is, first-termers serving enlistment terms of three years were permitted to separate up to one year before their normal end-of-service date. First-term (adjusted) reenlistment rates in our sample fell from an average of 0.15 in FY71 to less than 0.10

in both FY72 and FY73. More importantly, the bonus skills appear to have been affected more than proportionately by the early-out policy. Although the reason for this difference is unclear, it is possible that many personnel in bonus skills saw the early-out policy as symptomatic of future policies to limit reenlistments--including the elimination of bonuses--and thus chose to pursue a civilian career immediately. Under such conditions, our data may be inadequate for measuring bonus effects because the early-out option influenced the expected positive response to bonuses. Furthermore, as the reenlistment rates in our sample became concentrated in a very low range, the lack of variability among skill rates renders statistical analysis more difficult. Using adjusted reenlistment rates, the problem is extended beyond FY72 and into the FY73 data since individuals in the FY70 enlistment cohort who separated during FY72 are carried forward as FY73 losses.

In the case of the Navy, no similar large-scale force reductions occurred during the period. However, between FY71 and FY72 the Navy removed nine Ratings from the bonus eligible list, and an additional five between FY72 and FY73. Furthermore, many of the VRB-4 Ratings in our sample contained six-year obligors (6 YOs) and were excluded for reasons discussed above. The cumulative effect of these factors may have aggravated the statistical problem; that is, the variation in bonus awards between Ratings was diminished in the latter years, which may partially explain the lower and generally less precise estimates of bonus response for FY72 and FY73.

The Air Force case is unique in that here the bonus award levels declined radically between FY72 and FY73 in response to improved retention. The number of new bonus payments declined by a factor of almost three between the two years--a direct result of removing many AFSCs from the bonus eligible list. Moreover, the highest awards (VRB-4) were almost completely eliminated; by the end of FY73 only five skills were designated eligible for this award (down from 50 skills in FY71). This widespread decline in award levels probably suppressed the response to bonuses during FY73. Personnel who expected a large bonus would be unlikely to reenlist for a sharply reduced bonus or no bonus at all. Furthermore, as in the Army and Navy cases, the variation in

reenlistment rates across skills was reduced, causing the statistical measurement of bonus response to be less precise.

There is another factor, unique to the Air Force, which works to offset the observed decline in bonus response. During this period, first-termers were allowed to reenlist early--up to 24 months before normal end-of-service. This policy allowed individuals the option of executing early reenlistments in FY72 to avoid bonus reductions in their skill during FY73. Although the use of adjusted reenlistment rates should correct for early (or late) reenlistments, the appropriate variable for measuring bonuses is not well defined in these circumstances. For example, a skill designated eligible for VRB-2 in FY73 was likely to have been a VRB-4 skill in FY72; thus some unknown proportion of the reenlistees counted in FY73 actually received the higher bonus by reenlisting early.* The FY73 regression results are thus confounded by this problem of ambiguous bonus award levels.

Possible Biases in the Regression Results

In a cross-sectional analysis such as this, several biases may affect the results. The first bias may arise from the simultaneous relationship between the level of bonuses and reenlistment rates. Because bonus levels are partially determined by past retention behavior (e.g., shortages of trained manpower), it is likely that reenlistments in previous years will be negatively related to current bonus levels. Under these conditions the bonus variable (B) may not be independent of the error term, and estimation using OLS will yield estimates of bonus effects that are biased downward.

The second bias results from our failure to control explicitly for differences in the nonpecuniary returns offered by different military jobs. Bonuses are likely to be paid in skills where undesirable working conditions exist. Thus, this bias is the result of an omitted variable (nonpecuniary returns) being correlated with an included variable (the bonus). Again the bias works to depress our measurement of the marginal effect of bonuses.

*To compensate for this problem we set the value of the bonus variable in the Air Force FY73 equation to the highest award made to the skill in either FY72 or FY73.

Each of these types of bias leads to an understatement of the effect of bonuses. Although we cannot be certain of the magnitude of such biases, we can view the results as lower bound estimates of the bonus supply response. Nevertheless, some doubts remain about the regression results using Model I, and the effect bonuses have on first-term reenlistment rates. Although the FY71 results appear reasonable--bonus effects are consistently positive and of a believable magnitude--the results for the two latter years are far less satisfying, both in terms of the size of the effect and the statistical precision obtained. We have suggested a number of reasons for this pattern of results. However, it seemed desirable to develop a second approach for measuring bonus effects which would help in verifying these findings. We now describe an alternative model and data base that were used to investigate this question.

MODEL II

Data Used for Model II

The development of an alternative model for measuring bonus effects was guided primarily by data considerations. Thus, we begin with a discussion of the data base and variables. Whereas Model I required extensive data preparation using individual serviceman records, Model II was estimated using reenlistment statistics compiled regularly by each of the Services for use in their own manpower management systems and for reporting to OSD. These data were available in a standardized format for the years FY71-FY74 for the Army and Air Force, and FY71-FY73 for the Navy. The reenlistment rates are unadjusted; that is, reenlistments and separations are counted when they occur and are not linked directly to an enlistment cohort as are adjusted rates. Normally, however, a high percentage of reenlistments do occur at the end of the term. Furthermore, these rates apply to skills in the aggregate (Army MOS, Navy Rating, Air Force AFSC); no information on the types of individuals or their average paygrade status is recorded. Because each observation in the sample represents a skill, it was feasible to include all skills (MOSs, Ratings, AFSCs) in each service, although as discussed

below some further aggregation was necessary for both the Army and Air Force.

Another major difference between the Model I and Model II data bases concerns the definition of reenlistment eligibility. As noted above, for Model I all individuals in an enlistment cohort were eligible for reenlistment unless their separation code indicated misbehavior or physical disability. By contrast, for Model II, the reenlistment statistics reflect the Service's own definitions of eligibility. In general, this means that a higher proportion of individuals will be declared ineligible in the Model II data than in the Model I data; for example, individuals are frequently declared ineligible when they are allowed to separate up to three months early for the purpose of attending college.

The effect of this more liberal definition of ineligibility on reenlistment rates, and therefore on our statistical results, is far from certain. If the proportion of Service-defined ineligibles (which are counted eligible in the Model I data) is constant across skills, then the result would simply be to raise each skill's reenlistment rate by some constant percentage. In this case, the measurement of bonus effects should be quite similar regardless of which eligibility criterion is used. On the other hand, eligibility standards are likely to be linked to overall force size policy, and thus some skill groups may be subject to quite different eligibility criteria over time. Fortunately, as we see below, the question of eligibility does not seem too important for our study of bonus effects during FY71-FY74. Although there are some differences, both the Model I results (for FY71) and the Model II results for selected years are quite similar. However, the question of eligibility criteria is still important for the practical application of future bonus awards; it would be dangerous to conclude that the improvement factors reported in Sec. III can be applied uniformly to any set of reenlistment rate statistics. The question of who is declared ineligible and for what reasons needs to be further examined in juxtaposition with the bonus awards decision-making process.

Some additional aggregation of the skills was necessary in both the Army and Air Force. Because of the large number of MOSs and AFSCs, it was not practical to include individual constant terms for each of these skill designators in the pooled equation (see below). For the Army data we adopted the career management field (CMF) as the definition of an occupation; this resulted in 83 job categories for each of the four years, or a total of 332 observations. For the Air Force the five-digit AFSC codes were aggregated to the three-digit level, resulting in 47 job categories and 188 observations. The Navy data were obtained for 60 Ratings covering three years. (Ratings with 6 YOs and construction skill Ratings with lateral entry from the civilian labor market were excluded.) Thus 180 observations were available for the regression analysis.

VRB multiples 0 through 4 were used for the bonus variable rather than the dollar measure used for Model I. This change was adopted because no data on average pay grade by skill were available to construct the more precise bonus variable. For similar reasons, the pro-pay variable is measured as a level from 0 to 3. Finally, control variables representing each year were included to capture differences in reenlistment behavior common to all skills for the same year. The last year in each data series was taken to be the base year.* Thus the individual constant terms estimated for each skill predict the no-bonus reenlistment rate in the base year.

Model II Specification

Although the second set of data lacks the richness in individual attribute variables of the first set, there are two reasons why it is attractive for estimating the effects of reenlistment bonuses. First, the data cover almost all specialties in a military service, providing maximum coverage of the reenlistment bonus program. Thus, the problem encountered in the Navy with the first data set--that of an inadequate sampling of VRB skills--is lessened. Second, the data are exactly comparable for all years in the sample, making it possible to

* FY74 for the Army and Air Force; FY73 for the Navy.

analyze the full set of data at one time. This last feature makes it possible to control for the effect of job characteristics on reenlistment decisions--a major problem in the application of Model I.

The Model II supply equation takes the following form:

$$\text{Model II: } \log \left(\frac{r_{it}}{1 - r_{it}} \right) = \alpha_1 B_{it} + \alpha_2 PP_{it} + \beta_1 FY71 \\ + \beta_2 FY72 + \beta_3 FY73 + \sum_{i=1}^n \gamma_i J_i ,$$

where r_{it} = unadjusted reenlistment rate for skill i , year t ,
 B_{it} = reenlistment bonus multiple (0, 1, 2, 3, 4) for skill i , year t ,
 PP_{it} = proficiency pay (shortage specialty) multiple (0, 1, 2, 3) for skill i , year t ,
 $FY71, FY72, FY73$ = binary variables designating year group (for example, $FY71 = 1$ if data is for FY1971, and $FY71 = 0$ otherwise),
 J_i = a set of binary variables designating job categories (for example, $J_1 = 1$ for first job group, and $J_1 = 0$ for all other jobs),
and $\alpha_1, \alpha_2, \alpha_3, \beta_1, \beta_2, \beta_3$, and γ_i s are the coefficients to be estimated.

Model II is estimated by pooling the four years of data (three years in the Navy) and including an individual constant term (the J_i s) for each military skill. This technique is a crude but obvious way to capture both the inter-skill differences in types of individuals (race, mental ability, and education), as well as differences in job characteristics. Thus, this model does not allow any conclusions to be drawn regarding the effect of any specific attribute; however, since our major concern is to measure bonus effects on first-term reenlistment rates, this is not a serious shortcoming of the model.

Model II Regression Results

Model II was also estimated using the techniques of ordinary least squares, but the observations were not weighted as in the Model I regressions.* Table 2 presents the estimated coefficients and equation statistics; the individual constant terms and pro-pay coefficients (which were statistically insignificant in all cases) are not shown.

Table 2

MODEL II REGRESSION RESULTS USING UNADJUSTED REENLISTMENT RATES (FY71-FY74)

Eq.	Service/ Data Coverage	VRB Multiple	Year Group Variables			F- Statistic ^a	\bar{R}^2	Degrees of Freedom
			FY71	FY72	FY73			
(1)	Army (FY71-FY74)	0.128 (3.3) ^b	-1.3 (-16.1)	-1.6 (-19.7)	-0.36 (-4.5)	133.7	0.68	246
(2)	Army (FY71, FY73, FY74)	0.165 (4.8)	-1.3 (-17.0)	--	-0.37 (-4.8)	130.5	0.70	164
(3)	Navy (FY71-FY73)	0.210 (5.4)	-0.93 (-12.6)	-0.67 (-9.1)	--	69.4	0.64	117
(4)	Air Force (FY71-FY74)	0.129 (3.0)	-0.58 (-7.3)	-0.20 (-2.6)	-0.24 (-3.3)	14.3	0.39	137
(5)	Air Force (FY71, FY74)	0.168 (6.1)	-0.60 (-8.1)	--	--	32.5	0.59	45

^aF-statistic significance levels = 1 percent.

^bt-statistics are shown in parentheses.

Two versions of the Army and Air Force equations were estimated. Because of the aforementioned large force reduction which took place during FY72, this year's data were omitted in Eq. (2); the resulting coefficient for the bonus multiple variable increases from 0.128 (in

* Although it would have been desirable to run weighted regressions, a suitable computer program that could include a large number of variables and accomplish the required weighting was not readily available. For Model II data, however, weighting is less important since the number of eligibles in each cell does not vary widely across skills and thus heteroscedasticity is not a problem.

Eq. (1)) to 0.165. This second equation represents a period when force management policies were reasonably stable and seems, therefore, to be preferred to the first equation. Because of the large bonus level reductions that occurred between FY72 and FY73 in the Air Force case, it seemed wise to omit these years; this was done in Eq. (5). The VRB coefficient in Eq. (5) is 0.168 versus 0.129 obtained in all four years of data. This revised equation appears more appropriate for predicting future bonus effects since it represents reenlistment behavior in two years of stable force management and bonus policy.

The Navy coefficient is greater than either the Army or Air Force coefficients using Model II. One possible reason for this difference is that the Navy data we used does not contain Ratings with six-year obligors. Such Ratings typically include high training cost jobs, with high mental ability requirements. They also have been frequently eligible for the largest VRB awards. Since the individuals serving in these skills are likely to have relatively better civilian alternatives, they may respond less positively to bonus awards. Thus, the omission of these Ratings may have led to a larger Navy response.

COMPARISON OF BONUS COEFFICIENTS USING MODEL I AND MODEL II

The results of our two regression analyses may now be compared. The Model I bonus coefficients--representing the per thousand dollar effect of VRB--were converted to equivalent VRB multiple coefficients, the specification of Model II. We used an average pay grade of 4 in the Air Force and 4.5 in the Army and Navy.* Monthly base pay for an enlisted man with 4 years of service was then used to calculate the average bonus dollars per award multiple; multiplication of the Model I regression coefficients by this factor yields Model I values that are directly comparable to the Model II results obtained using unadjusted reenlistment rates. Table 3 displays the coefficients for the two models.

We have already commented on the pattern of declining bonus coefficients obtained using cross-sectional data to estimate Model I.

* These average pay grades were obtained from the Model I data base for first-term eligibles during FY71-FY73.

Table 3

COMPARISON OF MODEL I AND MODEL II VRB COEFFICIENTS

Supply Model and Data Coverage	Army	Navy	Air Force
Model I:			
FY71	0.132	0.228	0.233
FY72	(a)	0.087	0.174
FY73	0.093	0.085	0.078
Model II:			
Selected years for FY71 through FY74	0.165	0.210	0.168

SOURCE: Model I coefficients are from Table 1 adjusted to reflect bonus multiples. Model II coefficients are from Table 2: Eq. (2) (Army), Eq. (3) (Navy), and Eq. (5) (Air Force).

^aRegression coefficient for Army (FY72) is not statistically different from zero.

The important point shown in Table 3 is that the Model II results (for selected years) using unadjusted rates are remarkably similar to the FY71 Model I results. The Navy coefficients are virtually the same. The Army coefficient for Model II is 25 percent greater than for Model I (FY71), and the Air Force coefficient for Model II is about 25 percent less than the Model I (FY71) coefficient. In view of the different model specifications, reenlistment rate definitions, and data coverage, this agreement of results is encouraging since, as we stressed above, there are good reasons for questioning the Model I results for FY72 and FY73.

Although one might reasonably argue that the interservice differences shown in Table 3 are sufficient to warrant separate bonus policies for each Service, we have chosen to adopt the Army coefficient (0.165 from Army Eq. (2), Table 2) as a basis for constructing measures of bonus effects in each service.* We do this because the current policy

*These measures are presented in Sec. III.

of no lump-sum bonus payments suggests that a lower response to bonuses can be expected since we normally expect individuals to prefer lump-sum awards over anniversary payments. In general, the Army results reflect the current policy of no lump-sum payments more accurately than either those of the Navy or Air Force.*

DIFFERENCES IN BONUS EFFECTS BETWEEN OCCUPATIONAL GROUPS

At the outset we raised this question: Are there differences in the response to reenlistment bonuses that vary by occupational group? Before showing how our regression results may be modified to examine this issue, we consider the reasons why--in the context of our model of occupational choice--one might expect to find such differences. If we limit our attention to a group of homogeneous reenlistees, then different occupational group responses to bonuses must result from differences in the shape of the supply curve between the occupations. Such differences might result from factors ignored in our model such as the initial job assignment process; for example, if some skills attract or are assigned higher proportions of career motivated individuals, then the distribution of reservation wages[†] would be more concentrated for this group; this in turn implies that the slope of the supply curve is steeper and that in the relevant range the response to the bonus will be greater. The important point here is that since our models control for many factors that influence reenlistment behavior, any remaining differences in bonus response between occupational groups must be due to differences in factors such as "non-pecuniary returns."

To test for occupational differences we added separate bonus coefficients (one for each occupational group) to the regression equation,

* In FY71 Army lump-sum payments were 10 percent of total VRB payments; in FY74 this figure had risen to 78 percent. By contrast the Navy made 40-50 percent in lump-sum payments throughout the four-year period; the Air Force percentages ranged between 37 and 98 percent.

† The reservation wage for an individual is the minimum stream of future earnings that will cause him to reenlist. The distribution of all reservation wages for an occupational group uniquely defines the skills supply curve of reenlistments.

estimated the new equation using Model II data, and tested for statistical differences between the original equation (with a single bonus variable) and the revised equation. The major problem posed by this approach was one of definition: What groupings of MOSs, AFSCs, and Ratings represent a meaningful test for occupational differences and, at the same time, contain sufficient variation in bonus levels so that regression analysis is feasible? Below we discuss the tests for each service separately. The occupational groups that proved feasible are shown to differ widely between the Army and the Air Force/Navy; as a result, our conclusions must be interpreted cautiously.

Army Results

To define the Army occupational groups we use 1-digit Army CMF codes which are aggregates of the 3-digit codes used to define skills in the Model II data base. These codes and their general descriptions include: (1) Combat Arms; (2) Missile (Electronic) Repair; (3) Communications; (5) General Engineering; (6) Mechanical Repair; (7) Administration and Clerical; (9A) Medical and Dental; and (9B) Other Unrelated Skills. The variability in bonus awards within each occupational group for the FY71-FY74 period is considerable; thus the data do permit separate bonus coefficients to be estimated.

The statistical test that is appropriate here is the F-test. The null hypothesis is that the VRB coefficient is identical across occupational groups; the alternative hypothesis is that the coefficients are different. The VRB coefficients and equation statistics required for this test were estimated as

$$\begin{array}{l} \text{Null Hypothesis:} \\ (H_N) \end{array} \quad \begin{array}{l} \text{VRB} \\ 0.128 \\ (3.3) \end{array}$$

$$\bar{R}^2 = 0.68; \text{RSS} = 68.057; \text{degrees of freedom} = 246.$$

$$\begin{array}{l} \text{Alternative} \\ \text{Hypothesis:} \\ (H_A) \end{array} \quad \begin{array}{cccccccc} \text{VRB1} & \text{VRB2} & \text{VRB3} & \text{VRB5} & \text{VRB6} & \text{VRB7} & \text{VRB9A} & \text{VRB9B} \\ -0.07 & 0.21 & 0.20 & -0.016 & 0.168 & 0.227 & 0.301 & 0.176 \\ (-0.57) & (1.3) & (1.2) & (-0.08) & (0.97) & (1.6) & (2.0) & (0.95) \end{array}$$

$$\bar{R}^2 = 0.693; \text{RSS} = 66.200; \text{degrees of freedom} = 239.$$

The null hypothesis imposes seven restrictions on the estimates. Thus, the F-statistic is

$$F = \frac{(\text{RSS}(H_N) - \text{RSS}(H_A))/7}{\text{RSS}(H_A)/239} = \frac{(68.057 - 66.2)/7}{66.2/239} = 0.958 .$$

To reject the null hypothesis at the 95 percent level of significance requires a test statistic of 2.03 or greater; therefore, the Army results allow us to accept the null hypothesis that there are no occupational differences in the response to VRB.

Navy Results

For the Navy test, we divided the Ratings into two groups of skills, technical and nontechnical, using the DoD occupation codes. Technical skills were defined as those Ratings containing a majority of NECs in DoD groups I-IV. Nontechnical skills were similarly defined as having a majority of NECs in DoD groups O, V-VIII. The bonus coefficients estimated under the null and alternative hypotheses were

<u>Null Hypothesis:</u> (H _N)	$\begin{array}{c} \text{VRB} \\ (0.210) \\ (5.4) \end{array}$ $\bar{R}^2 = 0.64; \text{RSS} = 19.116; \text{degrees of freedom} = 117.$						
<u>Alternative Hypothesis:</u> (H _A)	<table border="0"> <tr> <td style="text-align: center; padding-right: 20px;"><u>VRB(I-IV)</u></td> <td style="text-align: center;"><u>VRB(O,V-VIII)</u></td> </tr> <tr> <td style="text-align: center; padding-right: 20px;">0.17</td> <td style="text-align: center;">0.26</td> </tr> <tr> <td style="text-align: center; padding-right: 20px;">(2.3)</td> <td style="text-align: center;">(5.1)</td> </tr> </table> $\bar{R}^2 = 0.65; \text{RSS} = 18.738; \text{degrees of freedom} = 116.$	<u>VRB(I-IV)</u>	<u>VRB(O,V-VIII)</u>	0.17	0.26	(2.3)	(5.1)
<u>VRB(I-IV)</u>	<u>VRB(O,V-VIII)</u>						
0.17	0.26						
(2.3)	(5.1)						

The null hypothesis imposes one restriction on the estimates. Thus the F-statistic is

$$F = \frac{(\text{RSS}(H_N) - \text{RSS}(H_A))/1}{\text{RSS}(H_A)/116} = \frac{(19.116 - 18.738)}{18.738/116} = 2.35 .$$

To reject the null hypothesis at the 95 percent level requires a test statistic of 3.93 or greater; thus, we accept the null hypothesis that there are no occupational differences in bonus response in the Navy.

Air Force Results

For the Air Force test we first attempted to use the nine standard DoD occupation groupings. However, this resulted in a breakdown of the estimation process since some groups were never bonus eligible during the FY71-FY74 period. To circumvent this problem a higher level of aggregation was used: as in the Navy test, two groups were defined representing technical and nontechnical skills. The technical skills include all AFSCs in DoD groups I-IV; the nontechnical skills include groups 0, V-VIII. The coefficients estimated for the bonus variables were

<u>Null Hypothesis:</u> (H _N)	$\frac{VRB}{0.129}$ (3.0)	
		$\bar{R}^2 = 0.39; \text{RSS} = 16.472; \text{degrees of freedom} = 131.$
<u>Alternative Hypothesis:</u> (H _A)	$\frac{VRB(I-IV)}{0.184}$ (3.6)	$\frac{VRB(0,V-VIII)}{0.061}$ (1.2)
		$\bar{R}^2 = 0.40; \text{RSS} = 16.152; \text{degrees of freedom} = 130.$

The null hypothesis imposes one restriction on the estimates. Thus the F-statistic is

$$F = \frac{(RSS(H_N) - RSS(H_A))/1}{RSS(H_A)/130} = \frac{(16.472 - 16.152)}{16.152/130} = 2.57.$$

To reject the null hypothesis at the 95 percent level requires a test statistic of 3.93 or greater; thus, the null hypothesis is also accepted for the Air Force.

Summary of Occupational Tests

The three service tests described above do not provide any evidence

suggesting that bonus effectiveness differs by occupational grouping. The Army test is the most stringent; here we were able to check for differential effects among eight occupation groups. The Navy and Air Force tests were more limited; only a technical/nontechnical comparison was possible. Although further research on this question--using more disaggregated occupation data--is clearly desirable, in the author's opinion the weight of the evidence to date justifies a bonus policy that treats all occupations on an equivalent basis.

PER DOLLAR DIFFERENCES BETWEEN AWARD LEVELS

At the outset we also asked the question: Do bonus awards have different per dollar effects that depend on the award multiple?

There is some limited evidence that the per dollar effects are different between multiples. The DoD improvement factors discussed in the following section imply that VRB levels one and three have a much greater marginal impact than do either levels two or four.

Our Model II regression results were extended to test for such possible differences by estimating equations with three separate bonus variables, weighted by the appropriate bonus level.* Table 4 presents the estimated coefficients for these revised equations. The coefficients for the bonus variables are remarkably similar for each service, indicating that on a per dollar basis, the different multiples are equally effective in raising reenlistments. All are statistically significant from zero at the 5 percent level (using a two-tailed test) with the exception of the Air Force VRB2 coefficient. As we have already suggested, this result for the Air Force is not unexpected, given the sharp decline in VRB levels between FY72 and FY73. Although Army results indicate that higher award levels produce higher per dollar effects, this pattern is reversed in the Navy results.

Statistical significance tests of these differences were performed in two ways: (1) t-tests were used to test the differences between VRB2 and VRB4 coefficients in each equation; (2) an F-test was used to

* VRB1 awards were virtually nonexistent during the period; thus only three award levels (2,3,4) were tested.

Table 4

PER DOLLAR EFFECTS OF BONUSES: REGRESSIONS USING MODEL II

Service/Year	VRB2	VRB3	VRB4	FY71	FY72	FY73	F-Statistic ^a	\bar{R}^2	Degrees of Freedom	RSS
Army (CMF) (FY71-FY74)	0.122 (1.4) ^b	0.129 (2.1)	0.130 (3.2)	-1.3 (-15.9)	-1.6 (-19.6)	-0.36 (-4.4)	88.3	0.68	244	67.864
Navy (FY71, FY72, FY73)	0.27 (3.4)	0.25 (4.7)	0.20 (4.8)	-0.90 (-11.8)	-0.65 (-8.6)	--	41.0	0.64	115	18.831
Air Force (FY71-FY74)	0.012 (0.22)	0.135 (2.5)	0.121 (2.8)	-0.62 (-1.7)	-0.22 (-2.9)	-0.25 (-3.4)	9.29	0.33	134	16.02

^aF-statistic significant at the 1% level.^bt-statistics are shown in parentheses.

test the null hypothesis that all three coefficients (VRB2, VRB3, VRB4) are equal. The results of these tests are summarized in Tables 5 and 6. The t-test results show that only in the case of the Air Force can the hypothesis of equal per dollar effects between the low

Table 5

t-TESTS FOR EQUALITY BETWEEN COEFFICIENTS
OF MULTIPLES 2 AND 4

Service	t-statistic	t-value Required to Reject Equality ^a	Accept or Reject Equality
Army	0.082	1.96	Accept
Navy	0.77	1.96	Accept
Air Force	2.30	1.96	Reject

^at-value required to reject equality at 5 percent level of significance.

and high award levels (2 and 4) be rejected. To repeat, this result is not unexpected, and during a more stable period it seems reasonable to expect that the per dollar response to level 2 awards in the Air Force would be consistent with the results observed for the Army and Navy. The F-tests for each service allow us to accept the null hypothesis that each of the bonus award multiples have equal per dollar effects on reenlistment rates.

Table 6

F-TESTS FOR EQUALITY BETWEEN COEFFICIENTS
OF MULTIPLES 2, 3, AND 4

Service	F-statistic	F-value Required to Reject Equality ^a	Accept or Reject Equality
Army	0.35	3.03	Accept
Navy	0.87	3.08	Accept
Air Force	1.82	3.06	Accept

^aF-value required to reject equality at 5 percent level of significance.

III. MEASURES OF BONUS EFFECTIVENESS

In this section, two measures of bonus effectiveness are derived using the regression results presented in Sec. II:

1. Bonus elasticity measures the percentage change in the reenlistment rate corresponding to a 1 percent change in military pay through application of the bonus.
2. The improvement factor (IF) measures the ratio of the reenlistment rate with a bonus to the rate that would obtain under no-bonus conditions. Improvement factors have been used in the past, and the results presented here represent our revisions of past tables.*

BONUS ELASTICITY

Method of Computation

We define the bonus elasticity of first-term reenlistments (E) to be $E = (\Delta r/B)(Y_m/r)$, where r = the reenlistment rate and Y_m = total second-term military pay. Thus, the bonus elasticity is comparable to the pay elasticity of other research; we have simply defined $B = \Delta Y_m$. For the purpose of calculating a bonus elasticity, a total military pay variable was constructed that includes base pay, special pay, allowances, and fringe benefits. Details of this construction are presented in App. B. Using FY72 pay data, the present value of Y_m with no bonus was determined to be \$25,566 for an E-5 with four years of Service.[†] The

* The original VRB table of improvement factors was derived from the DoD Study of Special Pays (1968); the study results were reworked into the IF table which first appeared in the Second Quadrennial Review of Military Compensation.

[†] The major assumptions used to compute this value for military pay were (1) a four-year time horizon, representing the mean term of reenlistment in each of the services; (2) a nominal discount rate of 15 percent; and (3) an expected growth in earnings of 5 percent per year.

Although our regression model did not use discounted pay variables, we chose to discount Y_m for the elasticity calculations. We did so

corresponding value of each bonus award level is \$1716, assuming a four-year reenlistment contract and a lump-sum payment.

Since the elasticity measure is expressed in terms of total military pay, the coefficient from our Army regression results which measures $\Delta r/B$ must be expressed in similar units. To accomplish this we convert the value of 0.165 from Table 2 (Eq. (2)) to dollars. Dividing by the mean dollar value of a bonus level for 1972 (\$1716) yields a "dollar" coefficient of 0.000096.

We now have all of the information necessary to compute the bonus elasticity. For the logistic model used in this study, the point elasticity is

$$E = \alpha_1 \cdot Y_m (1 - r_o) ,$$

where α_1 is the estimated bonus coefficient.

Using the arc elasticity provides a more precise measure where the change in Y_m is discrete; for a base $r_o = 0.20$, we compute the arc elasticity of the reenlistment rate with respect to pay as

$$\begin{aligned} E_{\text{arc}} &= 0.000096 (1/2(25,566 + 27,282)) \\ &\cdot (1 - 1/2(0.20 + 0.226)) = 1.996, \text{ or } \approx 2.0 . \end{aligned}$$

The interpretation of this elasticity is straightforward: a 1 percent change in military pay--using the bonus--results in a 2 percent change in the first-term reenlistment rate.

How Do Our Results Compare With Other Research Findings?

Measurement of the relationship between reenlistment rates and military pay has been the objective of many previous studies. In

because we wanted to compare our results to those from other military pay studies, where discounted military pay variables have commonly been used. Because we use the bonus coefficient, measuring $\Delta r/B$, for our calculations, there is no inconsistency in this procedure since lump-sum bonuses (requiring no discounting) have been commonplace in the past.

addition to the two Rand studies,^{*} we have reviewed 14 studies that have estimated the supply of first-term reenlistees as a function of pay.[†] Taken collectively, the studies cover the four military services and the time period 1960-1974. Although there are considerable differences in the methodologies of the studies, they have in common the fact that they are based on past reenlistment decisions rather than, for instance, on survey results. That is, the results are based on the actual behavior of first-term enlisted personnel rather than on responses to questions about how they will behave if offered a bonus. Thus, the results are not confounded with some of the real difficulties in using survey results to predict individual behavior.

Although the studies differ widely in the type of data employed, in the specification of the supply function (logistic, linear, etc.), and in assumptions regarding military pay, their results are surprisingly consistent. Table 7 provides a comparison of those results, expressed in terms of the pay elasticity of reenlistment. In some instances no pay elasticity estimate was reported by the author. For the purpose of calculating elasticities in these cases, the total military pay variable, defined in App. B, was employed to derive an elasticity using the reported statistical results. Where only improvement factors were reported, elasticity estimates were obtained by the conversion formula presented in App. C. An important point to remember in examining the results of most other studies is that only a few of them looked at bonuses per se. For the majority, bonuses were integrated into a single variable representing total military pay. Finally, the elasticity chosen for each study is evaluated at the mean reenlistment rate for the sample or, in cases where the elasticity was not reported, at the value of $r = 0.20$.

Some of the studies cited in Table 7 reported multiple elasticities. Although we tried to simplify the results wherever possible, we were still left with 20 point estimates and three interval estimates for the 16 studies reviewed here. If we take the midpoint of the interval in the three cases where elasticities were reported as a range, there

^{*} Foch (1974) and Enns (1975).

[†] Appendix D contains a detailed synopsis of the various studies.

Table 7

COMPARISON OF PAY ELASTICITIES FOR FIRST-TERM REENLISTMENTS

Author/Study	Date of Publication	Data Base		Pay Elasticity of Reenlistment
		Time Period	Service(s)	
<i>Sources of IF Tables</i>				
Enns (Rand)	1975	1971-74	Army, Navy, Air Force	2.00
1968 Study (OSD)	1968	1966-67	Total DoD	1.64-2.71
<i>Other Pay Studies</i>				
Gilman (CNA)	1965	1964	Navy	2.25
Quigley & Wilburn (AF)	1969	1960-66	Air Force	4.42
Nelson (IDA)	1970	1967	Army	2.43
Grubert & Weiher (CNA)	1970	1968	Navy	2.15
Wilburn (Gates Commission)	1970	(a)1968	Air Force	2.36
		(b)1960-65	Air Force	1.97
Nelson & Wilburn (IDA/OSD)	1972	1967-68	Total DoD	3.17
McCall & Wallace (Rand)	1969	1962	Air Force	3.2-5.2
Altergott (Navy PGS)	1972	1964-70	Navy	1.77
GAO Study	--	1971-72	Army	1.60
			Navy	2.11
			Air Force	2.30
Foch (Rand)	1974	1971-73	Navy	6.2
Kleinman & Shughart (CNA)	1974	1965-67	Navy	2.20
		1968-69	Navy	3.07
		1971-72	Navy	4.24
Enns (Rand)	1975	1971	Army	2.10
			Navy	2.58
			Air Force	3.40
Haber & Stewart (GWU)	1975	1971-72	Navy	2.38-2.69
Massell (Rand)	1975	1972	Air Force	2.3

SOURCE: See App. D and References.

are 23 separate elasticity estimates. These range in value from 1.6 to 6.2, with by far the largest concentration at the lower end of this range. The concentration of 14 of the 23 points in the range 1.97-2.58 is of the greatest significance for this report. The point estimate of 2.00 based on the present study results lies at the low end of this range. It is not clear whether to assign greater weight to our study based on a large data base of recent bonus experience or to the results of numerous studies varying in both quality and applicability to the bonus problem. However, it is gratifying to note that the results are generally consistent. The median estimate of the 23 elasticities is 2.30--somewhat greater than 2.00, but perhaps not too much greater given all the uncertainties in predicting reenlistment rates.

Table 7 indicates that a wide range of elasticities has been obtained. Although this is understandable, given the nature of the studies, some of the larger elasticities deserve closer scrutiny. Wilburn, for instance, applied a different model to the data used by Quigley and Wilburn and found an elasticity of 1.97 instead of 4.42. In the studies by Foch, and McCall and Wallace, the sample consisted of only a small subset of the enlisted force. McCall and Wallace considered only Air Force electronics specialists, whereas Foch looked only at the effect of bonuses in the nuclear-trained Navy. Moreover, with nuclear-trained personnel, the type of duty, the time of reenlistment (6 to 9 years), and other pays for which the man is eligible reduce the comparability with other specialties. The final elasticity greater than 4.0 was obtained by Kleinman and Shughart. This result was particular to the years 1971-1972 and was considerably larger than elasticities obtained in that study for earlier periods. We did not find elasticities of such a magnitude for the Navy in that period in either of our two studies. Rather, the Navy results in both cases were more comparable to the results obtained by Kleinman and Shughart for the years 1965-1969. Thus, the studies for which larger elasticity estimates were obtained do appear to represent special cases or unverified results.

In conclusion, we note an obvious fact not mentioned previously: All of the studies of first-term reenlistment have found a significant positive relationship between military pay and first-term reenlistment. All of the results indicate an elasticity greater than 1.5, and in most cases 2.0 or greater. Thus, other things equal, a 10 percent increase in military pay can be expected to yield a 20 percent increase in first-term reenlistments. This response is greater than the response of enlistments to military pay. The Gates Commission used an estimated elasticity of 1.25, although some of the individual studies indicated elasticities as high as 2.0. The evidence since the all-volunteer force pay increases is consistent with enlistment elasticities in the range of 1.0 to 1.25, depending on what other variables are included. Hence it appears that the supply of first-term reenlistees to the military is more elastic than the supply of initial volunteers. Finally, our results for the Army, although slightly conservative, are consistent

with the main pattern of results obtained from other studies of first-term reenlistments.

IMPROVEMENT FACTORS

A second measure of bonus effects is the improvement factor (IF), defined as the ratio of the reenlistment rate with a bonus to the rate which would obtain with no bonus. Improvement factors are related to pay elasticities by a simple formula. Since

$$IF = \frac{r_o + \Delta r}{r_o} = 1 + \frac{\Delta r}{r_o} \quad \text{and} \quad E = \frac{\Delta r}{r_o} \cdot \frac{Y_m}{\Delta Y_m},$$

it follows that

$$IF = 1 + E \cdot \frac{\Delta Y_m}{Y_m}.$$

In the remainder of this section we examine two sources of IFs: the DoD tables derived from the DoD Study of Special Pays (1968), and our own tables based on the results of this study.

DoD Improvement Factors and Conditions of "Save Pay"

The switch from the VRB to SRB programs included provisions for the eventual elimination of regular reenlistment bonuses (RRBs) which had previously been paid to reenlistees in all skills. In effect, this change increased the available bonus award levels from four to five. Furthermore, the expanded SRB program also provided for a sixth level to be authorized in Navy skills with nuclear trained personnel.

Under the SRB legislation, the RRBs were not eliminated instantaneously but will be phased out under the provision of "save pay." According to this provision, personnel who enlisted prior to June 1, 1974, are still eligible for RRBs in all skills. Where the skill is designated SRB eligible, reenlistees may choose between the RRB and the SRB awards. Thus some individuals will be eligible for RRBs until approximately June 1, 1977 (Army, Marine Corps), and June 1, 1978

(Navy, Air Force), assuming three- and four-year initial enlistments, respectively.*

To reflect these changes under SRB, the VRB table of IFs was updated to represent bonus effects with RRBs eliminated. Table 8 shows the original DoD VRB table, and Table 9 shows the revisions made to this table to reflect SRB program changes.

Table 8

DOD VRB IMPROVEMENT FACTORS (ALL SERVICES: FY63-FY67)

No Bonus Reenlistment Rate (r_o)		VRB Level				
\geq	$<$	0	1	2	3	4
0	10	1.00	1.30	1.35	1.65	1.75
10	15	1.00	1.30	1.35	1.65	1.70
15	20	1.00	1.25	1.30	1.55	1.60
20	25	1.00	1.20	1.25	1.45	1.60
25	30	1.00	1.15	1.20	1.35	1.40
30	35	1.00	1.10	1.15	1.25	1.30
35	50	1.00	1.05	1.10	1.20	1.25

SOURCE: DoD Instruction 1304.15, September 1970, p. 4.

Inconsistencies in DoD Tables

To construct Table 9, each column in the VRB table (Table 8) was shifted one column to the right, and two new columns were created for SRB1 and SRB6 awards. This procedure means, however, that the same improvement will be noted for a level two SRB *whether or not* the individual was eligible for a regular bonus in its place; i.e., whether or not save pay applies. This is logically inconsistent inasmuch as each increase in the bonus is expected to have some effect on the reenlistment rate. Although there are admittedly problems in extrapolating an IF table where no data are available, a consistent and logical

* Six-year enlistees in the Army and Air Force will be eligible for up to \$2000 in regular reenlistment bonuses until 1980.

Table 9

DOD SRB IMPROVEMENT FACTORS (ALL SERVICES: FY63-FY67)

No Bonus Reenlistment Rate (r_o)		SRB Level						
\geq	$<$	0	1 ^a	2	3	4	5	6 ^a
0	10	1.00	1.25	1.30	1.35	1.65	1.75	1.85
10	15	1.00	1.25	1.30	1.35	1.65	1.70	1.75
15	20	1.00	1.20	1.25	1.30	1.55	1.60	1.65
20	25	1.00	1.15	1.20	1.25	1.45	1.50	1.55
25	30	1.00	1.10	1.15	1.20	1.35	1.40	1.45
30	35	1.00	1.05	1.10	1.15	1.25	1.30	1.35
35	50	1.00	1.00	1.05	1.10	1.20	1.25	1.30

SOURCE: Unpublished DoD paper, September 1974.

^aExtrapolated from VRB improvement factors.

treatment of bonus effects would dictate a different construction of this IF table. Where save pay applies, the bonus program operates as before except that VRB1 is equivalent to SRB2 and so forth. Thus the entries in Table 8 can be shifted to the right by one column, as was done in Table 9. However, the improvement from awarding an SRB1 can be expected to be insignificant since an SRB1 is almost equivalent to the RRB under save pay.* Thus, the IF for SRB1 should be 1.0. After save pay expires, the preferable treatment would be to leave columns 1-4 unchanged on the original VRB table and then add IFs for SRB5 and SRB6. The base reenlistment rate for applying the IF table would then be the reenlistment rate without either an SRB or an RRB.

Improvement Factors Resulting from the Present Study

The regression results of the present study have been used to derive two sets of improvement factors, which measure bonus effects with save pay (Table 10), and without save pay (Table 11). Although

*The total dollar awards are equivalent. The difference is that although RRBs are always paid in lump-sum, SRB1's can only be paid in installment payments under current policy.

Table 10

IMPROVEMENT FACTOR TABLE (WITH SAVE PAY)

No Bonus Reenlistment Rate (r_o)		SRB Level					
\geq	$<$	1	2	3	4	5	6
0	10	1.00	1.17	1.36	1.59	1.85	2.14
10	15	1.00	1.15	1.33	1.52	1.73	1.97
15	20	1.00	1.14	1.30	1.48	1.66	1.86
20	25	1.00	1.13	1.28	1.43	1.60	1.77
25	30	1.00	1.12	1.26	1.39	1.54	1.69
30	35	1.00	1.11	1.23	1.36	1.48	1.61
35	50	1.00	1.10	1.19	1.29	1.38	1.48

SOURCE: Based on calculations by the author using the regression results of Sec. II.

Table 11

IMPROVEMENT FACTOR TABLE (WITHOUT SAVE PAY)

No Bonus Reenlistment Rate (r_o)		SRB Level					
\geq	$<$	1	2	3	4	5	6
0	10	1.17	1.36	1.59	1.85	2.14	2.48
10	15	1.15	1.33	1.52	1.73	1.97	2.22
15	20	1.14	1.30	1.48	1.66	1.86	2.08
20	25	1.13	1.28	1.43	1.60	1.77	1.95
25	30	1.12	1.26	1.39	1.54	1.69	1.84
30	35	1.11	1.23	1.36	1.48	1.61	1.74
35	50	1.10	1.19	1.29	1.38	1.48	1.57

SOURCE: Based on tabulations by the author using the regression results of Sec. II.

the statistical findings of our study are based on data from the VRB program, we have translated these findings into equivalent SRB effects by a simple redefinition of award levels: e.g., VRB1 = SRB2, and so on.

As with the elasticity estimate presented above, the supply equation used to construct the IF tables is taken from the Army regression results using Model II. At present, we feel this estimate of bonus response is the most appropriate for use in each service under the current policy of no lump-sum payments. Details of the derivation of Tables 10 and 11 are presented in App. E.

In Table 10 the improvement factors for SRB1 awards are shown as 1.0. This is because under save pay, reenlistees in all skills are eligible for RRBs; thus, the base reenlistment rates already reflect the response to level 1 bonuses. To construct Table 11--SRB IFs without save pay--each pay column in Table 10 is shifted one column to the left and a new column created for level 6 awards.

Several caveats regarding Table 11 should be noted:

1. The IFs for SRB level 1 are derived from the estimated supply function. At the present time, this seems the most reasonable approach since we have no hard evidence on the response to this bonus level. However, it is important to recognize the possible range of uncertainty surrounding these estimates.* On the one hand, there may be threshold effects in this range such that for bonuses less than some minimum (say \$3000), no improvement in the reenlistment rate, on average, can be expected. Conversely, the offer of a level 1 bonus may induce a larger *marginal* response than in the case of the higher awards. However, our latest research suggests that there is no per-dollar difference in bonus effectiveness for SRB levels 2 through 5 under the save-pay provision. Thus, it is reasonable to expect that level 1 awards will elicit a similar marginal response.

* Thus uncertainty regarding SRB1 effects seems particularly important at present. First-term reenlistment rates have been unusually high during recent months; this suggests that lower bonus levels will be used more frequently than in the past.

2. Similarly, the level 6 IFs in Tables 10 and 11 have been extrapolated using the estimated supply equation. Here again, we are predicting effects for which no previous experience is observable. However, Foch (1974) in a recent study of the Nuclear Trained Petty Officer (NTPO) Bonus suggests that the IFs shown in Tables 10 and 11 for level 6 may be quite accurate. The NTPO Bonus is analogous to an SRB6 Zone-B bonus in that it is awarded for service commitments past the six-year point. However, for nuclear trained enlisted personnel, it represents their first true reenlistment decision; these individuals are six-year obligors who automatically extend their initial enlistment for two years as a prerequisite for entry into the nuclear skills. Data for the initial NTPO bonus year (CY73) show that the reenlistment rate for all NTPOs with six to nine years of service more than doubled (from 15.1 percent to 34.7 percent).^{*} Thus the implied IF is 2.30 for NTPO bonuses; this compares with an IF of 2.08 for SRB6, for skills with $r_0 = 15$ percent.

Comparison of DoD and This Study's IF Tables

There are two important differences between the DoD's and this study's SRB improvement factor tables. Under conditions of save pay, it is appropriate to compare Tables 9 and 10 (ignoring for the moment the inconsistency in Table 9 described above). Figure 1 illustrates these differences graphically for two base reenlistment rates. It is apparent that our IFs are less extreme at both the low and high ranges of the base rates. For a relatively low no-bonus rate of $12\frac{1}{2}$ percent, the DoD factors are greater over most award levels. The reverse is true for a relatively high rate of $27\frac{1}{2}$ percent. Another important difference is that our factors do not display the ratchet effects between award levels that are evident in the DoD factors. For purposes

^{*} See Foch (1974), pp. 40-48.

of managing the bonus program this is an important difference. Using the DoD table, one would almost never choose levels 3 or 5 since they buy very little relative to levels 2 and 4. By contrast, our table suggests a much wider range of options.

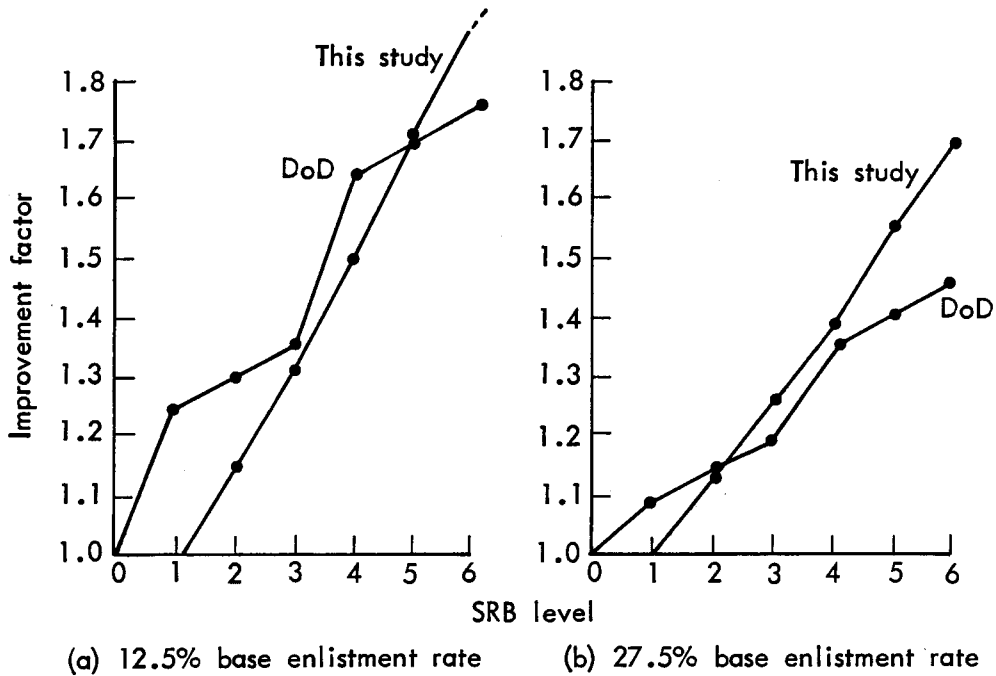


Fig. 1 — Comparison of DoD's and this study's improvement factors

IV. CONCLUSIONS

This summary of our study's major findings represents what we believe is now known about bonus effects and what remains to be learned. Our results are in two parts: (1) questions for which we have provided quantitative or statistical answers and (2) those issues for which only qualitative judgments have been advanced.

QUANTITATIVE FINDINGS

1. The impact of selective reenlistment bonuses seems clearly established by the regression results. In each of the three services analyzed, the regression coefficients--which measure the change in reenlistment rates with respect to the bonus--are always positive and generally of high statistical significance. The bonus elasticity is estimated to be 2.0 using representative Army results for the period FY71-FY74. Although this elasticity is somewhat lower than other research has reported, it seems appropriate for managing the bonus program under the policy of no lump-sum payments.
2. The regression results do suggest some minor interservice differences in bonus responsiveness; however, the pattern of these differences is not consistent over time nor between models that use different specifications and data. Since it is difficult to explain, a priori, why eligible reenlistees in one service branch should respond more or less positively to the offer of a bonus, we believe that the bonus can be expected to be equally effective across services. We did not analyze data for the Marine Corps; however, the relative concurrence of the results obtained for the Army, Navy, and Air Force suggest that bonuses can be expected to have similar effects on Marine Corps retention.
3. Occupational group characteristics do not seem to affect the response elicited by the bonuses. That is, when all of the differences among individuals (pre-service education, mental

ability, race, etc.) and jobs (nonpecuniary rewards) are held constant, the bonus can be expected to have the same marginal impact across broadly defined skill groups such as electronic repair or service and supply. This conclusion should be regarded as tentative, however, since there are some difficult statistical problems in testing for differences in bonus response by occupational group.

4. SRB award multiples three, four, and five each produce approximately the same marginal increase--2 to 3 percentage points--in first-term reenlistment rates. Or, in other words, each of these three bonus levels has the same impact per dollar of award. Experience with SRB multiples one, two, and six has been either nonexistent or very limited in the past. Although further research will be necessary to establish precisely the per dollar effects of these multiples, for the present it seems reasonable to assume that each of the six multiples produces the same per dollar response. The improvement factor tables presented in this study incorporate this assumption.

QUALITATIVE ISSUES AND EVIDENCE

1. We have seen that personal attributes (level of pre-service education, race, mental ability, age, and dependency status) are related to the level of reenlistment rates in each service. However, we believe that a single supply curve--of logistic form--is adequate for measuring the relationship between reenlistment rates and bonuses. This conclusion implies that personal attributes do not affect the *shape* of the supply curve. In other words, for the purpose of predicting reenlistment response to bonuses, it is sufficient to have a reliable estimate of no-bonus reenlistment behavior for the skill--and then apply the appropriate improvement factor--rather than identify subgroups by attribute and make separate estimates.
2. The question of whether reenlistment bonuses are more effective when paid in lump-sum versus installment payments remains

unresolved. A properly constructed experiment to answer this question could not be devised with the available data for FY71-FY74; more specifically, information on the proportion of reenlistees who were awarded lump-sum bonuses was not available on a skill-by-skill level of detail. Moreover, in the past, lump-sum payments have been controlled in part by budgetary considerations, and thus the actual choices faced by bonus-eligible reenlistees were not clear.*

3. Finally, at the beginning we raised the question of whether bonus effects have varied over time due perhaps to the general improvement in retention which occurred in the post-Vietnam era or the transition to an All-Volunteer Force (AVF). By comparing our results with those of prior research, we conclude that bonus effects have been quite stable over the last ten years. The 1968 DoD study produced a set of improvement factors which, viewed globally, are quite similar in magnitude to our results. Other research--covering many different time periods--has focused on military pay (rather than bonuses per se) and has yielded elasticity estimates of similar size. However, we note that during most of the period 1966-1974, civilian labor market conditions remained quite tight; further evidence for periods with more slack--such as the present one--needs to be generated to completely answer this question.

* For some crude evidence on this lump-sum issue see Enns (1975), pp. 32-34.

Appendix A

LOGARITHMIC VERSUS LINEAR GOODNESS-OF-FIT TESTS

To help in the selection of a functional form with which to estimate the supply function, a statistical test (known as the Box-Cox test) was performed using the Model II regressions for each service. The problem with comparing results using different functional forms is that the residual sum of squares from two regressions cannot be directly compared where the dependent variables are not functionally equivalent. Thus, for example, if we wish to compare two equations, one with Y as the dependent variable and the other with log Y, the comparison of the residual sum of squares is meaningless, since by a proper choice of measurement units, one residual sum may always be made smaller than the other.

The Box-Cox test is designed to overcome this problem. By standardizing the dependent variables so as to make their variances insensitive to the unit of measurement, two equations can be made comparable. For the case of a log versus linear comparison, the appropriate transformation is the inverse of the geometric mean of the independent variable. The Box-Cox test then relies on a nonparametric test statistic, distributed according to a chi-square distribution with one degree of freedom.*

We applied this test to two functional forms--linear and semi-log--of the supply function using Model II. The results are shown in Table A.1, where the equations estimated include the same variables as those reported in Table 2 of Sec. II. In each case the null hypothesis--that the residual sum of squares of the two forms are equal--is rejected. In both the Army and Air Force results, the semi-log model provides a better fit of the 1971-1974 reenlistment data. Only the Navy results suggest that a linear supply function provides a superior fit to the data.

*For a discussion of the use of this procedure, see G.E.P. Box and D. R. Cox, "An Analysis of Transformations," *Journal of the Royal Statistical Society, Series B*, 1964, pp. 211-243.

Table A.1

TESTS FOR EQUIVALENCE BETWEEN LINEAR AND SEMI-LOG SUPPLY FUNCTIONS

 H_N : RSS (linear) = RSS (semi-log) H_A : H_N false

Service and Data Coverage	Sample Size	RSS Linear	RSS Semi-log	d-Statistic ^a	Critical Value ^b	Accept or Reject H_N	"Best" Function
<u>Army</u>							
FY71-74	332	65.34	42.99	69.5	6.63	Reject	Semi-log
FY71, FY73, FY74	243	22.3	14.04	56.2	6.63	Reject	Semi-log
<u>Navy</u>							
FY71-FY73	180	10.98	14.8	26.9	6.63	Reject	Linear
<u>Air Force</u>							
FY71-FY74	188	10.36	8.96	13.65	6.63	Reject	Semi-log
FY71, FY74	94	2.37	3.69	42.6	6.63	Reject	Semi-log

^aThe d-statistic is defined as: $d = \frac{T}{2} \left| \log_e \left(\frac{\text{RSS } (H_N)}{\text{RSS } (H_A)} \right) \right|$ where T = sample size. This

statistic follows a chi-square distribution with one degree of freedom.

^bChi-square value for 1 percent significance level.

This test may seem "ad hoc," but as Rao and Miller have observed:

...it is actually similar to the so-called maximum likelihood estimation, except in this case we are not interested in the functional form that maximizes the likelihood value over the entire space. [Rather] we are choosing one of two well-specified functional forms with the larger likelihood value.*

The results displayed in Table A.1, while not entirely conclusive, do suggest that nonlinear models are more appropriate for measuring bonus effects than linear models. The issue of whether the logit model used in Sec. II is superior to several other nonlinear forms is still open. Nevertheless, as was pointed out above, there are some practical reasons for preferring the logit model; in any event, for the range of first-term reenlistment rates observed most often in the past (0.10-0.30), the log, semi-log, and logit models all yield very similar estimates of the pay elasticity and improvement factors.

* Potluri Rao and Roger L. Miller, *Applied Econometrics*, 1971, Wadsworth Publishing Co., Belmont, California, 1971, p. 109.

Appendix B

CALCULATION OF TOTAL MILITARY PAY (Y_m)

The appropriate concept in measuring military pay elasticities of reenlistment is the total value of military pay to the potential reenlistee. This valuation should include all pay and benefits the potential reenlistee expects to receive. A list of such pay and benefits might include base pay, quarters and subsistence allowances, special and incentive pays, reenlistment bonuses, housing and food, commissary and exchange privileges, medical benefits, insurances and death benefits, veterans benefits, and retirement. In calculating a value for total military pay for the potential reenlistee, there are four concepts that must be considered:

1. The *time horizon* over which the individual considers military pay: Is it the next year, the next term of service, the remainder of the military career?
2. The *discounting* of future income, reflecting the marginal rate of time preference of the potential reenlistee.
3. The *expectations* of future pay raises and promotions resulting in higher military pay in future years.
4. The *perception and valuation* of noncash components of pay, such as income received "in kind" (food, housing, medical care) and implied tax advantage.

Previous studies of first-term reenlistment designed to estimate the pay elasticity of reenlistment have differed somewhat in their assumptions regarding these concepts. However, the purpose of this appendix is merely to calculate a military pay variable to serve as a base for calculating bonus elasticity and converting improvement factors (from other studies) into pay elasticities. Given the diversity in the assumptions about military pay, we are willing to settle for some rough calculations of military pay. With respect to time horizon, discounting, and expected pay increases, we adopt

1. A four-year time horizon, representing the mean term of reenlistment in each of the services.*
2. A nominal discount rate of 15 percent.
3. An expected growth in earnings of 5 percent per year.

With respect to the valuation of all the components of military compensation, we have made two calculations indicating that the value of allowances and benefits was approximately one-half of base pay at two different periods (1967 and 1973) covered by the reenlistment studies. In 1973 for an E-5 with no dependents we estimated the following values for military allowances and fringe benefits:

Housing allowance ^a	\$1112
Subsistence allowance ^a	602
Medical benefits	200
Commissary and exchange	
privileges	300
Tax advantage ^b	470
	<hr/> \$2684

^aValue of housing allowance may be overstated for single men living in post housing. Similarly, value of subsistence allowance may understate value of food served on posts. These effects will tend to offset one another.

^bBecause allowances and income in kind is not taxable.

This is 48.8 percent of the base pay of an E-5 with four years of service. In an earlier study, Nelson (1970) estimated the value of allowances and other benefits to be 57 percent of base pay for a similar enlisted man in 1967. Hence the assumption of 50 percent for the entire 10 years covered by the reenlistment studies may not be too far off.

Military pay appropriate for the reenlistment decision has four components: basic military pay (M_t), allowances and fringe benefits

* Navy, Marine Corps, and Air Force have four-year reenlistment terms. Army reenlistment terms extend from three to six years.

(A_t), special and incentive pays (S_t), and the reenlistment bonus (B). The present discounted value of this pay is

$$Y_m = \sum_{t=1}^4 \frac{1}{(1+i)^t} (M_t + A_t + S_t + \rho_t B) , \quad (B.1)$$

where t is the year designation, i is the rate of discount, and ρ_t is the proportion of the bonus expected to be paid in each year. If a lump sum is expected, $\rho_1 = 1$, and $\rho_2, \rho_3, \rho_4 = 0$. If installment payments are expected, all values of ρ would lie between 1.0 and 0.

This formulation of pay can be simplified by employing assumptions already made and making further assumptions. For instance, we assume that base pay is expected to grow at a constant rate g per year ($g = 0.05$). Thus,

$$M_t = M(1+g)^t . \quad (B.2)$$

Allowances and fringe benefits equal 0.50 of the value of base pay for the second term. Thus,

$$\sum_{t=1}^4 \frac{1}{(1+i)^t} A_t = 0.5 \sum_{t=1}^4 \left(\frac{1+g}{1+i} \right)^t M . \quad (B.3)$$

The value of special and incentive pays is assumed to remain constant at S dollars per year in the second term. Under the SRB program, the bonus is equal to the SRB multiplier (m) times monthly base pay ($M/12$) times the term of reenlistment (4). Thus,

$$B = m \frac{M}{3} . \quad (B.4)$$

If, as was common under the VRB program, bonuses were lump-sum, then pay can be written as

$$Y_m = 1.5 D M + \frac{mM}{3} + S' , \quad (B.5)$$

where

$$S' = S \left(\sum_{t=1}^4 \frac{1}{(1+i)^t} \right),$$

and

$$D = \sum_{t=1}^4 \left(\frac{1+g}{1+i} \right)^t.$$

Where $g = 0.05$, $i = 0.15$, per assumption, then $D = 3.2028$. Studies of special and incentive pay by the DoD Comptroller have reported average pay for E-5s ranging from \$388 for the Navy to \$188 for the Marine Corps. The DoD average is approximately \$300. The value S' is then \$856.

Appendix C

COMPARISON BETWEEN IMPROVEMENT FACTORS AND PAY ELASTICITIES

Studies of first-term reenlistees have tended to report the effects of pay either in terms of elasticities or specialized measures like improvement factors. The *military pay elasticity* of reenlistment is defined as the ratio of the proportional increase in reenlistment rates to the proportional increase in military pay, other factors remaining the same. In the *arc-elasticity* measure, there are discrete changes in the variables:

$$E = \frac{\Delta r/r}{\Delta Y_m/Y_m} . \quad (C.1)$$

In the *point-elasticity* measure, changes are infinitesimal, and the notation of calculus can be employed:

$$E = \frac{\partial r/r}{\partial Y_m/Y_m} = \frac{Y_m}{r} \frac{\partial r}{\partial Y_m} . \quad (C.2)$$

The *improvement factor* is the ratio of the reenlistment rate with a bonus to the reenlistment rate without a bonus. Thus,

$$IF = 1 + \frac{\Delta r}{r} . \quad (C.3)$$

From (C.1) and (C.3) we see that

$$IF - 1 = E \frac{\Delta Y_m}{Y_m} . \quad (C.4)$$

Equation (C.4) gives us a method of translating improvement factors into elasticities and vice versa. The translation will be more accurate

if we limit ourselves to small changes and bonuses.* The *incremental improvement factor*, I_m , is the improvement resulting from increasing the bonus multiplier from m to $m + 1$. The elasticity implied by a given improvement factor is

$$E = (IF_m - 1) \frac{Y_m}{\Delta Y_m}, \quad (C.5)$$

where ΔY_m is the difference between the reenlistment bonus for multiplier m and the bonus for multiplier $m + 1$. In the notation of the preceding section,

$$\Delta Y_m = \frac{M}{3}$$

for a term of four years. Using this value and Eq. (B.5), the elasticity conversion is

$$E = (IF_m - 1) \left(\frac{1.5 D \cdot M + mM/3 + S'}{M/3} \right) \quad (C.6)$$

or

$$E = (IF_m - 1) (4.5 D + m + 3S'/M). \quad (C.7)$$

For a given bonus multiplier m and a given value of D (3.2 by assumption), the conversion depends only on S'/M . This is a very small correction, and we ignore it except for cases such as nuclear-trained personnel where S' is obviously important.[†] Where D takes on its assumed value,

* Arc elasticities are most accurate for small changes in military pay.

[†] If $S' = \$856$, and M for an E-5 with four years is \$5148--the appropriate 1972 figures--then $3S'/M$ is 0.50, or only 3 percent of the value 4.5D.

$$E = (IF_m - 1)(14.4 + m) . \quad (C.8)$$

This equation is used to convert improvement factor results into pay elasticities. In some cases, such as the original DoD study of effects of bonuses, incremental improvement factors are too unstable to use in converting to elasticities. In this case, we will use the simple improvement factor comparing reenlistment with a multiple of m to reenlistment without a bonus. This requires a slightly different form of the elasticity formula to ensure precision in the calculation.* In this formula,

$$E = \frac{IF_m - 1}{(IF_m + 1)/2} \cdot \frac{14.4 + m/2}{m} . \quad (C.9)$$

*The arc elasticity can also be calculated as $E = (\Delta r / \bar{r})(\bar{Y}_m / \Delta Y_m)$, where \bar{r} and \bar{Y}_m represent the average of reenlistment and pay with and without the bonus. Thus, instead of being the initial rate r_0 with no bonus, \bar{r} is the average value $1/2 (r_1 + r_0)$. Similarly, for \bar{Y}_m .

Appendix D

SUMMARY OF MILITARY PAY STUDIES

Table D.1 provides a synopsis of some sixteen studies which attempt to link military pay to first-term reenlistment. These studies made over the past 10 years consider reenlistment covering the years 1960-1974. The distribution of the studies across the services is as follows: Army, 6; Navy, 19; Marine Corps, 3; and Air Force, 10. The total is greater than sixteen because five of the studies include results from at least three of the military services. Many of these studies produced numerous results, based on different subsamples of the population or based on different assumptions. We have chosen the result, or results, that we view as most representative. In the case where no result is so identified, we have used our own judgment and tried to report results based on the broadest possible sample. Footnotes to the table document our method of calculating elasticities for each of the sixteen studies.

Table D.1

SYNOPSIS OF FIRST-TERM REENLISTMENT STUDIES THAT ESTIMATE EFFECTS OF MILITARY PAY

Author	Organization	Service Studied	Year(s) Covered	Type of Analysis	Supply Function	Military Pay Variable	Measures Reported	Implied Elasticity
Gilman	CNA	Navy	1964	Cross-section	Log	Total pay	Elasticity	2.25 ^a
1968 VRB Study	OASD(M&RA)	Total DoD	1966-67	Trend analysis	Ratio	VRB	Improvement factor	1.64-2.71 ^b
Quigley & Wilburn	Hq-USAF	Air Force	1960-66	Pooled cross-section time-series	Logistic/semi-log	Cash pay	Elasticity	4.42 ^c
Nelson	IDA	Army	1967	Cross-section	Log	Total pay	Elasticity	2.43 ^d
Grubert & Weiher	CNA	Navy	1968	Cross-section	Log	Total pay	Elasticity	2.15 ^e
Wilburn	Gates Commission	Air Force	1968	Cross-section	Logistic/semi-log	Total pay	Elasticity	2.36 ^f
Wilburn	Gates Commission	Air Force	1960-66	Pooled cross-section time-series	Logistic/semi-log	Total pay	Elasticity	1.97 ^f
Nelson and Wilburn	IDA & OSD(SA)	Total DoD	1967-68	Cross-section	Logistic/semi-log	Total pay	Elasticity	3.17 ^g
McCall & Wallace	Rand	AF electronics	1962	Cross-section	Logistic/semi-log	Total pay	Elasticity	3.2-5.2 ^h
Altergott	Navy PGS	Navy	1964-70	Pooled cross-section time-series	Log	Total pay	Elasticity	1.77 ⁱ
GAO	--	Total DoD	1971-72	Cross-section changes	Ratio	VRB	Improvement factor	Army: 1.60 ^j Navy: 2.11 ^j AF: 2.30 ^j
Foch	Rand	Navy NTPO	1971-73	Time-series	--	Special bonus	Reenlistment change	6.2 ^k

Table D.1--Continued

Author	Organization	Service Studied	Year(s) Covered	Type of Analysis	Supply Function	Military Pay Variable	Measures Reported	Implied Elasticity
Kleinman & Shughart	CNA	Navy	1965-72	Pooled cross-section time-series	Logistic/semi-log	VRB	Elasticity	1965-67: 2.20 ^l 1968-69: 3.07 ^l 1971-72: 4.24 ^l
Enns	Rand	Army, Navy, Air Force	1971	Cross-section	Semi-log	VRB	Elasticity	Army: 2.10 ^m Navy: 2.58 ^m AF: 3.40 ^m
Haber & Stewart	George Washington University	Navy	1971-72	Change	--	RMC	Elasticity	2.38-2.69 ⁿ
Massell	Rand	AF electronics	1972	Cross-section	Normal	VRB	Elasticity	2.3 ^o
Enns	Rand	Army, Navy, AF	1971-74	Pooled cross-section time-series	Logit	VRB	Elasticity	2.00 ^p

^aVerbal report of results.

^bSpecial pay study: Use DoD improvement factor table for reenlistment rate of 0.20 to 0.25 and converted to elasticity through Eq. (C.8) of this report.

^cQuigley and Wilburn (1969), p. 22.

^dNelson (1970), p. II-6-13.

^eGrubert and Weiher, p. II-8-11.

^fCross-section elasticity from Gates Commission Report (1970), p. II-7-10, and Wilburn's dissertation (1970), p. 72. Time-series elasticity, p. 109.

^gNelson and Wilburn (1972), p. 23.

^hMcCall and Wallace (1969), p. 307.

ⁱWeighted average of results from Altergott (1972), p. 85. Pay assumptions chosen to most closely approximate the assumptions of this report.

^jUse improvement factors from GAO Study (1974), p. 7, and convert to elasticity using Eq. (C.8).

^kFrom Foch (1974). Assume increase in reenlistment rate from 0.151 to 0.347.

^lKleinman and Shughart (1974), p. 14.

^mEnns (1975), p. 26.

ⁿHaber and Stewart (1975), p. 13.

^oMassell (1975), p. 27.

^pEnns (1975). Based on Army equation for FY71-FY74, viewed as best estimate of effects of VRB made as installment payments.

Appendix E

FUNCTIONAL FORM UNDERLYING THIS STUDY'S IMPROVEMENT FACTORS

Tables 10 and 11 in Sec. III were derived from regression results using a logistic specification for the supply equation.

The equation used to construct Tables 10 and 11 is derived as follows:

$$IF_i = \frac{r'}{r_o} = \frac{1/1 + e^{-\alpha - \gamma B_i}}{1/1 + e^{-\alpha}} = \frac{1 + e^{-\alpha}}{1 + e^{-\alpha - \gamma B_i}},$$

where IF_i = improvement factor for SRB level i ,

$\alpha = \log_e(\bar{r}_o/1 - \bar{r}_o)$ where \bar{r}_o is the midpoint of each range for r_o shown at the left of each table,

$\gamma = 0.165$, the estimated coefficient from Army supply Eq. (2), Table 2,

B_i = SRB level ($i = 1 \dots 6$).

Using this model, bonus effects vary depending on where one starts on the supply curve, i.e., the no-bonus rate. Specifically, in the most common logistic specification, Δr --the change in r_o --increases in absolute value for values of $r_o < 50$ percent and declines thereafter. For each award level the resulting IFs decline as r_o increases (but not as sharply as with a linear model where Δr is a constant). By contrast, a semi-log model produces a pattern of IFs that are constant over all r_o , since this model implies that the *percentage* change r_o is equivalent over all initial values.

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